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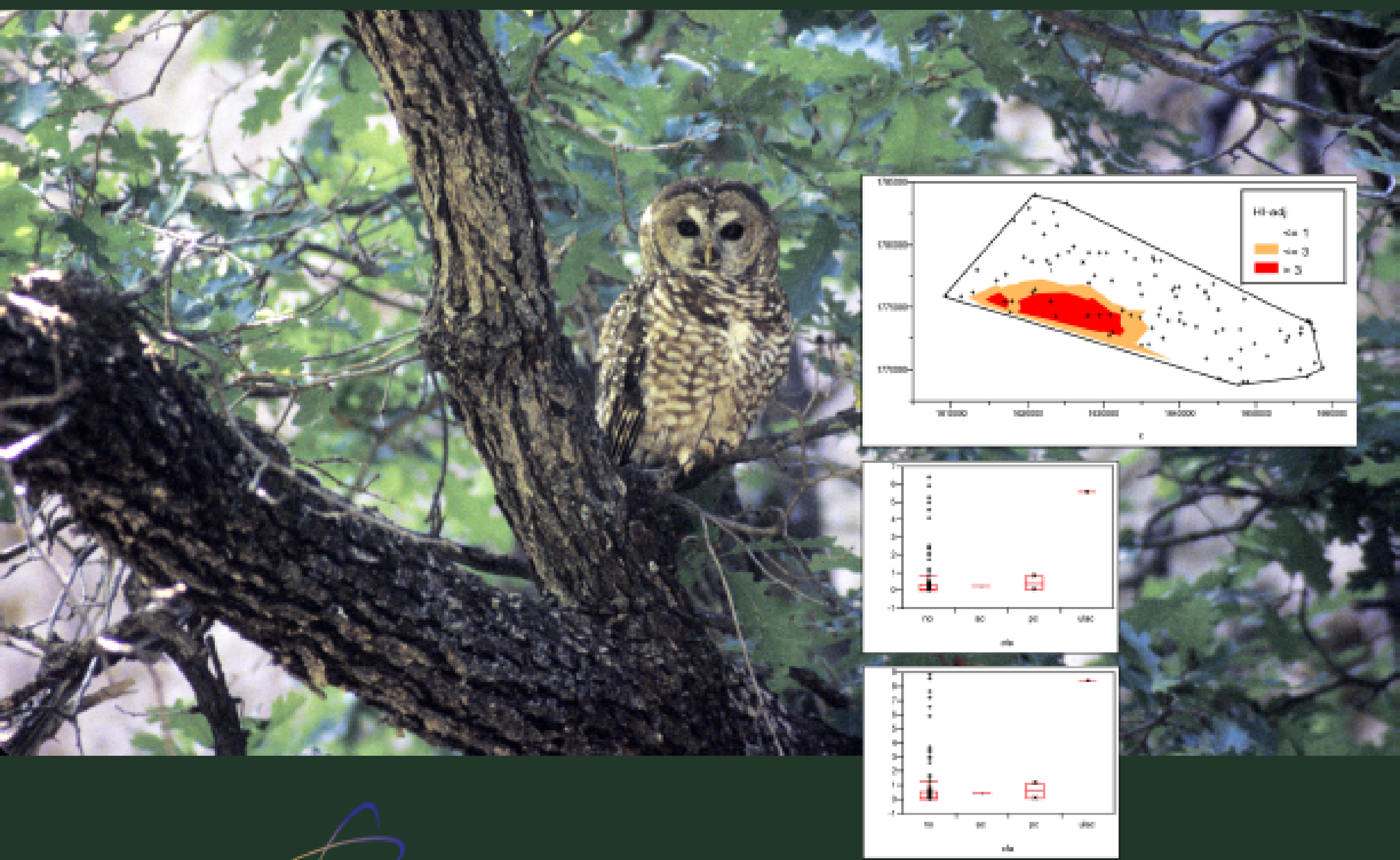
Modeled Ecological Risk to the Deer Mouse, Mexican Spotted Owl, and Western Bluebird at the Los Alamos National Laboratory Using ECORSK.7



Los Alamos
NATIONAL LABORATORY

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About the cover: Mexican spotted owl at LANL (photo taken by David Keller of LANL's Ecology Group); contour plot shows hazard index (HI) distribution in study area and box plots show HI values by subarea within study area. Both were generated from ECORSK.7 output.

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CONTENTS

Figures

Tables

ACRONYM LIST

ACS	Acid Canyon, South Fork
BCF	bioconcentration factor
BRMP	biological resources management plan
COPEC	contaminant of potential ecological concern
CS	Critical Study
DARHT	Dual-Axis Radiographic Hydrodynamic Test (facility)
DL	detection limit
eco-SSL	ecological soil screening level
EEU	ecological exposure unit
EPA	U.S. Environmental Protection Agency
EPAQM	U.S. Environmental Protection Agency Quotient Method
ER	Environmental Restoration (Project)
ESL	ecological screening level
GIS	geographic information system
GMM	geometric mean
HI	hazard index
HQ	hazard quotient
HR	home range
ID	(grid cell) identification (value)
LANL	Los Alamos National Laboratory
LAPCIR	Los Alamos and Pueblo Canyons Investigation Report
LOAEL	low observed adverse effect level
NOAEL	no observed adverse effect level
ORNL	Oak Ridge National Laboratory
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
pHI	partial hazard index
PRS	potential release site
PTSE	Primary Toxicity Study Evaluation
PTV	Primary Toxicity Value
RCRA	Resource Conservation and Recovery Act
RRES-RS	Risk Reduction and Environmental Stewardship Division Remediation Services
SNL	Sandia National Laboratories
SVOC	semivolatile organic compound
SWEIS	Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory
T&E	threatened and endangered (species)
TRV	toxicity reference value

EXECUTIVE SUMMARY

The Los Alamos and Pueblo Canyons Investigation Report (LAPCIR) contains an assessment of human health and ecological risk regarding legacy contaminants in two large canyons (Los Alamos and Pueblo) at the Los Alamos National Laboratory (LANL). ECORSK.7 is a model written in FORTRAN95 computer code that has been applied for the LAPCIR project as one of many lines of evidence for evaluating potential adverse ecological effects. ECORSK.7 assesses potential risk to terrestrial animals over large spatial areas on the basis of the U.S. Environmental Protection Agency Quotient Method. Estimates of animal exposure over a gridded area are compared with assumed health effects levels to generate hazard indices (HIs) using the equations: $HQ_{ij} = \frac{exposure_{ij}}{effect_{ij}(orTRV)}$ and $HI_i = \sum_{j=1}^{n} HQ_{ij}$,

where HQ_{ij} = hazard quotient for receptor i to contaminant of potential ecological concern (COPEC) j (unitless), $exposure_{ij}$ = exposure to COPEC j for receptor i (units are mg of COPEC per kg body weight per day or mg/kg/day), $effect_{ij}$ = effect level or safe limit (represented by a toxicity reference value [TRV]) for exposure to COPEC j for receptor i (mg/kg/day), and HI_i = hazard index for receptor i to n COPECs (unitless). The mean total HI is the arithmetic average of HIs for a specified total number of nest sites established for a receptor—1000 for the deer mouse and bluebird and 100 for the owl—totaled across all COPECs.

ECORSK.7 integrates biological, ecological, and toxicological information using geographic information system interfaces so that all model input and output are spatially explicit. The application of ECORSK.7 to LAPCIR helps to integrate the previous screening level ecological risk assessments performed in the Los Alamos and Pueblo Canyons watershed across a broader area and, although it is intended to evaluate contaminants in sediment, results can also have some application to managing specific contaminated areas. Collectively, model and empirical measures used together are complementary; field data help to test model assumptions, and model results enhance spatial and temporal coverage of field measures.

During ECORSK operation, the model assigns nest sites within a nesting habitat on the basis of responses by the operator (random or as specified) and differentiates the spatial components by the grid cell ID. Random nest site selection is based on Monte Carlo methods, or alternatively, nests can be specifically assigned to particular grid cells such as a grid cell occupied by a potential release site (PRS) and/or a grid cell known to contain an actual nest or other niche of an animal. The distribution of nest/focal point locations can be non-weighted throughout the ecological exposure unit (EEU) whereby each grid cell within a nesting habitat or EEU receives equal consideration, or distribution can be weighted on the basis of the natural distribution tendencies of the animal if distribution data are available. At LANL, land cover types, including classes of animal habitat, have been determined from aerial data that have been ground-verified and animal distributions by land cover type or habitat have been measured. Given the specification of the total number of nest sites for each execution ("run") of ECORSK.7, the number of nest sites/focal points (ECORSK.7 can accommodate up to 5000) for each habitat type can be weighted on the basis of density or abundance data. While the relative weight of each habitat type is based on animal data, it is also intersected with the proportion of the total EEU made up by a given habitat type.

The ECORSK model was designed to contribute to a Tier 2 level of assessment, which generally is more realistic than screening assessments. For example, arithmetic mean COPEC sample values and background concentrations were used rather than maximum values or upper tolerance limits. Geometric mean TRVs were used for the baseline scenario rather than minimum TRVs. [A detailed process for selecting TRVs is described in the Methods section of the main report.] Actual animal distribution data were used and their natural movement tendencies were simulated rather than artificially restricting their distribution to a contaminated area. ECORSK.7 computes HIs and HQs for risk associated with three source-types: unadjusted, background, and adjusted. Unadjusted sources consists of contributions from background (natural or regional) and, presumably, from Laboratory operations. The contaminant data used in ECORSK.7 were from sources of measured canyon sediment concentrations, interpolated canyon sediment concentrations, and measured non-canyon soil concentrations (largely mesa-top PRS data from the Site-Wide Environmental Impact Statement database). Eight different model execution scenarios were identified for the deer mouse to test the sensitivity of the model to different data sets or data manipulations.

The receptors chosen for application of ECORSK.7 were the deer mouse (*Peromyscus maniculatus*), Mexican spotted owl (*Strix occidentalis lucida*), and Western bluebird (*Sialia mexicana bairdi*). These species collectively represent a variety of receptors with regard to attributes related to social/cultural and ecological factors, the availability of toxicology information, and model strength factors. The number of nest sites specified were 1000 for the deer mouse and bluebird and 100 for the owl—all nest sites were randomly selected. In addition to weighting the distribution of nest sites and the simulated foraging on the basis of real data (as discussed above) for all three receptors, foraging by the owl was weighted on the basis of distance from nest site within the home range of each nest site.

An "Adjusted Baseline" was identified is the most reasonable scenario on which to base conclusions. Mean total HIs that combined background and anthropogenic sources of contaminants ranged from 0.67 to 9.78, but over 90% of the risk for the deer mouse and bluebird were from background contributions. Large background contributions to risk indices is an indication that TRVs may be overly protective (too low) and/or that mean background values of some of the COPECs were relatively high as the result of a few high values that went into the average. About 0.4% of deer mouse populations were predicted to experience a moderate (HIs>10.0) level of potential impact from anthropogenic sources of environmental contamination and 5.4% had a small (HI = 1–10) potential for impact. An unadjusted mean total HI of 0.67 for the owl indicates that, on average, no effects are expected because exposure doses did not exceed the assumed safe limit (no-observed-adverse-effect-levels [NOAEL]). About 13% of owl populations were predicted to experience a small (HIs = 1–10) level of potential impact from anthropogenic sources of environmental contamination and 5.4% had a small (HI = 1–10) potential for impact. About 10.6% of the bluebird population could experience adverse impacts from anthropogenic sources of COPECs. COPECs dominating the HQ contributions to nest sites with the highest HIs were thallium (mean HQ = 2.25) and antimony (mean HQ = 2.07) for the deer mouse; cyanide (mean HQ = 0.6) and Aroclor-1254 (mean HQ = 0.5) for the owl; and Aroclor-1254 (mean HQ = 1.1), naphthalene (mean HQ = 1.0), cyanide (mean HQ = 0.8), lead (mean HQ = 0.6), and vanadium (mean HQ = 0.5) for the bluebird. Only HQs above 1.0 exceed the established no-observed-adverse-effects levels, so, even when nest sites with the highest HIs are segregated and evaluated separately, only thallium, antimony, and Aroclor-1254 pose a small potential for impacts.

The results of this assessment are valuable for enhancing the spatial and temporal coverage of empirical studies that were conducted concurrently. Given the uncertainty in toxicological values used worldwide, the main use of the results is as relative values. Few geographical areas of relatively high HIs originating from presumably anthropogenic sources of COPECs have been identified and should be investigated. Model results indicate that, on average, there is little, if any, potential for impact to the Mexican spotted owl and a small potential for impact to the deer mouse and Western bluebird from environmental contaminants.

The higher values in the range of distribution of HIs indicate a moderate potential for impact to the mouse and bluebird in some areas of LANL and a small potential for impact to the owl in some areas of LANL; however, again, background sources of contaminants were the dominant contributors to the HIs.

Considering the conservatism injected into the assessment, there was good agreement between HIs/HQs in this study and HIs/HQs resulting from a screening study. Considering changes in parameters that have taken place since an ECORSK.4 assessment of the Mexican spotted owl in 1997, there was good agreement between HIs of the old study compared with HIs in the current study. Enabling the owl to forage to the full extent of its home range without restriction to the LAPCIR study area may have utility in future assessments. The Adjusted Baseline scenario should serve as the ECORSK.7 baseline for the study area and is the scenario to which other assessments should be compared in the future.

Modeled Ecological Risk to the Deer Mouse, Mexican Spotted Owl, and Western Bluebird at the Los Alamos National Laboratory Using ECORSK.7

Gil Gonzales[1], Randall Ryti[2], Patricia Newell[3], Anthony Gallegos[3], and Sherri Sherwood[4]

ABSTRACT

ECORSK.7, a FORTRAN95 model for assessing risk to animals from contaminants, was applied at the Los Alamos National Laboratory to three receptors—deer mouse (*Peromyscus maniculatus*), Mexican spotted owl (*Strix occidentalis lucida*), and Western bluebird (*Sialia mexicana bairdi*)—in a study area including Los Alamos and Pueblo Canyons, smaller side canyons, and interspaced mesa tops. Application of the model was in support of the Los Alamos and Pueblo Canyons Investigation Report as one line of evidence toward decisions regarding risk management in Los Alamos and Pueblo Canyons. The results of the model application are valuable for enhancing the spatial and temporal coverage of empirical studies that were conducted concurrently. Given the uncertainty in toxicological values used worldwide, the main use of the results is as relative values. Few geographical areas of relatively high hazard indices (HIs) originated from presumably anthropogenic sources of contaminants of potential ecological concern (COPECs) and should be investigated. Mean total HIs that combined background and anthropogenic sources of contaminants ranged from 0.67 to 9.78, but over 90% of the risk for the deer mouse and bluebird were from background contributions. COPECs dominating the hazard quotient (HQ) contributions to nest sites with the highest HIs were thallium (mean HQ = 2.25) and antimony (mean HQ = 2.07) for the deer mouse; cyanide (mean HQ = 0.6) and Aroclor-1254 (mean HQ = 0.5) for the owl; and Aroclor-1254 (mean HQ = 1.1), naphthalene (mean HQ = 1.0), cyanide (mean HQ = 0.8), lead (mean HQ = 0.6), and vanadium (mean HQ = 0.5) for the bluebird. Only HQs above 1.0 exceed the established no-observed-adverse-effects levels, so, even when nest sites with the highest HIs are segregated and evaluated separately, only thallium, antimony, and Aroclor-1254 pose a small potential for impacts. Results for the model application to the Mexican spotted owl agreed well with an assessment conducted in 1997 and with empirical and screening studies conducted concurrently with this assessment. HI contours were useful in enhancing spatial coverage by empirical studies and are applicable to populations of animals. An Adjusted Baseline was identified as the most reasonable scenario on which to base conclusions; it should serve as the ECORSK.7 baseline for the study area and is the scenario to which other assessments should be compared in the future.

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INTRODUCTION

The Los Alamos and Pueblo Canyons Investigation Report (LAPCIR) contains an assessment of human health and ecological risk regarding legacy contaminants in two large canyons (Los Alamos and Pueblo) at the Los Alamos National Laboratory (LANL). ECORSK.7 is a model written in FORTRAN95 computer code that has been applied for the LAPCIR project as one of many lines of evidence for evaluating potential adverse ecological effects (Katzman 2002). ECORSK.7 assesses potential risk to terrestrial animals over large spatial areas on the basis of the U.S. Environmental Protection Agency (EPA) Quotient Method (EPAQM). Estimates of animal exposure over a gridded area are compared with assumed health effects levels to generate hazard indices (HIs). ECORSK.7 integrates biological, ecological, and toxicological information using geographic information system (GIS) interfaces so that all model input and output are spatially explicit.

BACKGROUND

Ecological risk screens and other risk-related information have indicated the need to perform aggregate studies of a more robust nature in the Los Alamos and Pueblo Canyons watershed. The LAPCIR assessments of ecological effects from legacy contaminant releases at LANL were undertaken to assist in making remediation decisions and to develop plans for future environmental monitoring. In addition to Los Alamos and Pueblo Canyons, the area considered in this assessment includes the smaller, subsidiary canyons Acid and DP. The Los Alamos and Pueblo Canyons watershed (Fig. 1) includes about 19 km of canyons in areas upstream and downstream of LANL sources of contaminants. Diverse terrestrial and aquatic biological communities in these canyons are potentially exposed to contaminated sediment, surface water, and shallow alluvial groundwater.

In the years 1996–1999, the potential impact of chemical and radiological contaminants on threatened and endangered (T&E) species in the environment surrounding LANL was appraised using ECORSK.5. Performed as required for the Record of Decision for the construction of the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility at LANL as part of the DARHT Environmental Impact Statement, these assessments also became the ecological risk assessments of record for the *Site-Wide Environmental Impact Statement (SWEIS) for Continued Operation of the Los Alamos National Laboratory* (USDOE 1999) and a related site-wide biological assessment. Much has changed in contaminant data sets and other parameters since the assessments of T&E species.

Shortly after issuance of the SWEIS, LANL began formal planning on comprehensive biological resources management to provide policy, guide biological resources surveillance and monitoring, and ensure regulatory compliance. The development of a biological resources management plan (BRMP) was identified as necessary for the Laboratory to have continued success in the dual objectives of operating a nuclear industry in harmony with a sustained surrounding environment. This plan included the need to avoid the hindrance of the land management objectives of adjacent Native American pueblos and federal land management agencies.

With trace levels of chemical (inorganic and organic) and radioactive contamination in the LANL-related environment, understanding risk to wildlife that is presented by these contaminants is an important biological quality issue emphasized by many stakeholders of the Laboratory. With a region-wide spatial scope identified by the BRMP, planners identified

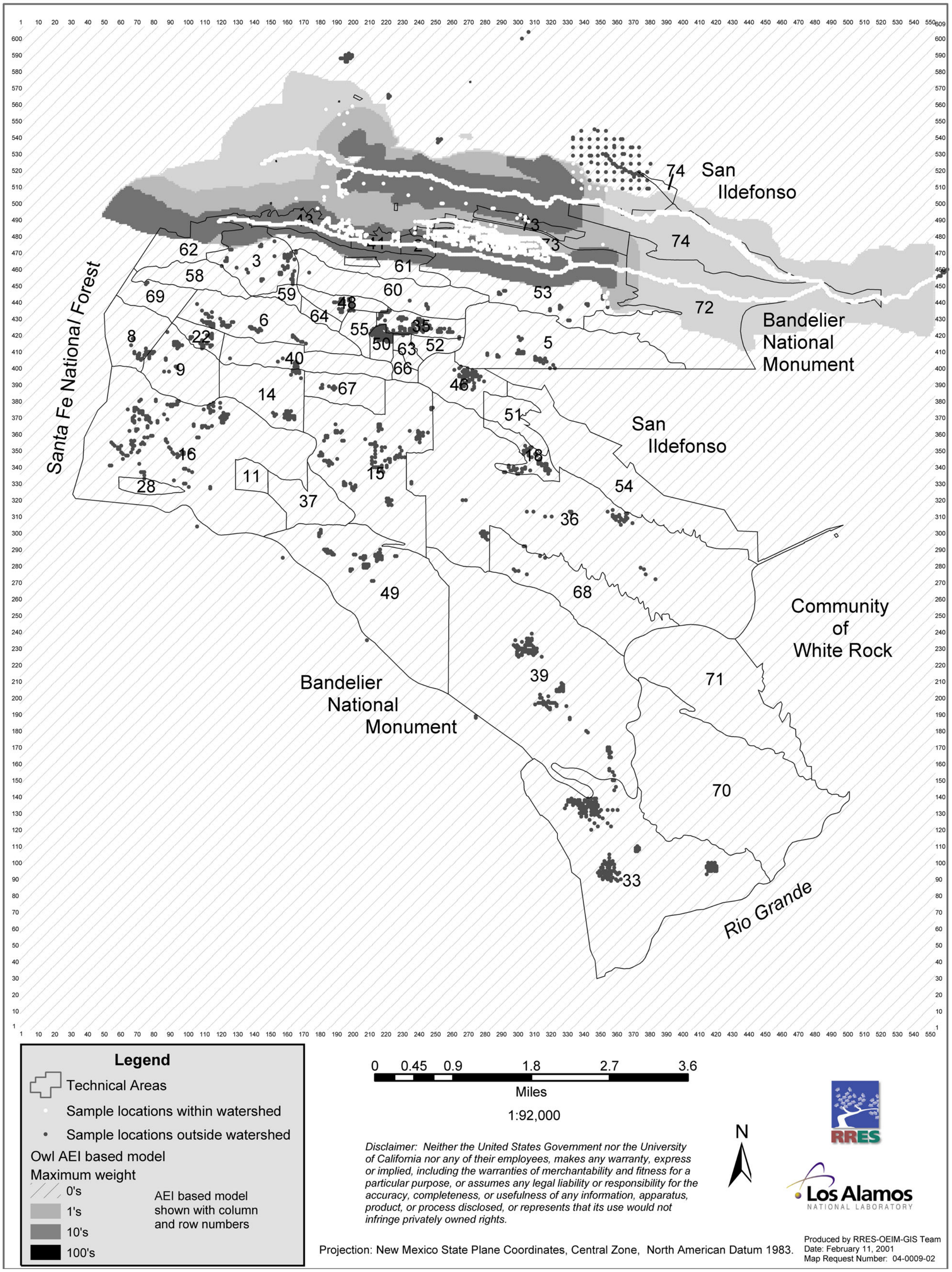


Figure 1. Study area—Los Alamos and Pueblo Canyons watershed.

ECORSK as a tool that could satisfy the needs of the BRMP planning and implementation process because ECORSK has its strength in assessing large areas of land, thus having the same broad spatial extent as the regional context of the BRMP. And, ECORSK allows the use of real animal distribution data to determine the spatial dynamics for estimating exposure. ECORSK.6 was applied to the Rocky Mountain elk (*Cervus elaphus*), the American robin (*Turdus migratorius*), and the deer mouse (*Peromyscus maniculatus*)(Gonzales et al. 2002). The spatial extent covered by ECORSK was also envisioned to help satisfy the "broad ecosystem-level component" requirement of the Natural Resource Damages Assessments (43 CFR 11).

This current application of the ECORSK model helps to integrate the previous screening level ecological risk assessments performed in the Los Alamos and Pueblo Canyons watershed into a broader spatial context. Previous screening level assessments have been documented in the "reach" reports (Reneau et al. 1998a, b, c; Katzman et al. 1999), which evaluated affected media–primarily sediments–in canyon bottoms. Other screening assessments have been performed on point-source areas of contamination known as "potential release sites" (PRSs) by LANL's Risk Reduction and Environmental Stewardship Division Remediation Services (RRES-RS), formerly the Environmental Restoration (ER) Project under the Resource Conservation and Recovery Act (RCRA). This application of the ECORSK model is intended to evaluate contaminants in sediment but will also provide useful results for PRSs. Because contaminant data have been updated for sediments and not PRSs, the results cannot be considered definitive, but are certainly indicative of the kinds of risks and risk sources one may determine from an evaluation that includes the most current data for both PRSs and canyons sediments. Thus, application of ECORSK is intended to complement screening-level assessments already completed and the ongoing aggregate assessment (LAPCIR). Results from ECORSK.7 on the potential toxicity of deposits of radioactive and nonradioactive contaminants in soil and sediment are being used as one of many lines of evidence for evaluating potential adverse ecological effects. Collectively, model and empirical measures used together are complementary; field data help to test model assumptions, and model results enhance spatial and temporal coverage of field measures. The operations strategy, documentation of code, mathematical models used, and previous applications of ECORSK have been documented in detail (Gallegos et al. 1997a; Gonzales et al. 1998a, b; 2002). Changes to the code since the 1990s have been substantial enough that it is time to document it again in the near future.

METHODS

Receptors

The receptors chosen for application of ECORSK.7 were the deer mouse, Mexican spotted owl (*Strix occidentalis lucida*), and Western bluebird (*Sialia mexicana bairdi*). These species collectively represent a variety of receptors with regard to attributes related to social/cultural and ecological factors and contaminant and model strength factors. Deer mice are omnivores with a tendency for relatively high exposure to contaminants resulting from consumption of invertebrates as a food source and a relatively high food intake rate (relative to body weight); their distribution and density are known such that their distribution can be used in ECORSK.7 in a manner that would affect contaminant exposure calculations; they have a wide distribution, which is conducive to the ability of ECORSK.7 to simulate large spatial areas; they are within an animal guild for which toxicological information exists, i.e., mammals; and their use as an indicator species has been expressed by external stakeholders (Gonzales et al. 2002). The deer mouse is also often the receptor on which risk screens are based (USDOE 2000; LANL 1999).

The Mexican spotted owl is a top carnivore, and, therefore, since ECORSK.7 includes soil-to-receptor and food-chain transfers of contaminants, modeling of the owl addresses the issue of potential biomagnification; as a T&E species that is federally protected, it has very high social importance; its diet and habitat are well known and these are key attributes of the assessments; the owl was a subject of assessment with ECORSK.5 in 1997 (Gallegos et al. 1997a) and it has been the subject of numerous studies at LANL, therefore it has surfaced as a key indicator species.

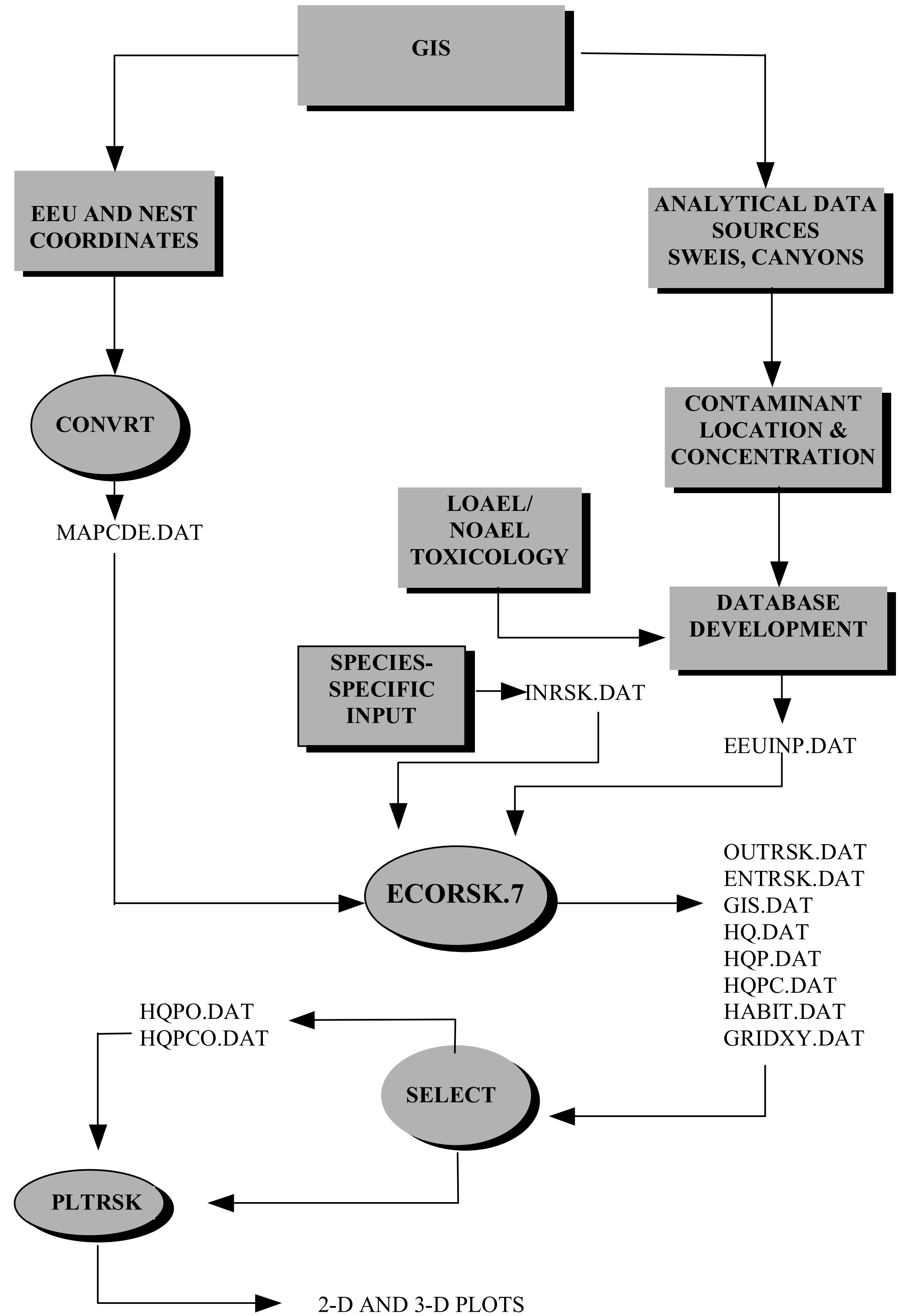
The Western bluebird is a ground foraging insectivore; with some individuals residing at LANL year-around the bluebird has been the subject of studies at LANL for five years now (e.g., Fair and Colestock 2003; Fair and Sommer 2003), therefore, habitat use and other population ecological information specific to LANL has been measured. Some of the nest box monitoring network data are being used as lines of evidence in LAPCIR (Katzman 2002). Attributes of these receptors as entities for measuring potential adverse effects as well as their value as indicator species for different land management agencies are discussed in a previous report (Gonzales et al. 2002).

ECORSK.7 Organization and Operations

A summary of the general organization of ECORSK.7 in relation to GIS information and input and output files is shown in Figure 2. ECORSK.7 integrates several different kinds of GIS information; contaminant data; and animal biological, ecological, and toxicological information.

The basic spatial unit used by ECORSK.7 is a 30 × 30 m grid that is assigned a unique grid cell identification (ID) value, which corresponds to a unique New Mexico State Plane Coordinate System ‘x’ and ‘y’ value. All environmental information, such as contaminant of potential ecological concern (COPEC) concentrations, are cataloged by location (grid cell ID) using this spatial system. Establishing the spatial extent of the Los Alamos and Pueblo Canyons watershed was accomplished by overlaying a grid on the watershed. Some receptors, such as the owl, have nesting habitats that are discrete from the surrounding foraging areas (or home ranges [HRs]), which together comprise ecological exposure units (EEUs) as defined in the ECORSK model.

Nest Site/Focal Point Designation. During ECORSK operation, the model assigns nest sites within a nesting habitat on the basis of responses by the operator (random or as specified) and differentiates the spatial components by the grid cell ID. Random nest site selection is based on Monte Carlo methods, or alternatively, nests can be specifically assigned to particular grid cells such as a grid cell occupied by a PRS and/or a grid cell known to contain an actual nest or other niche of an animal. The distribution of nest/focal point locations can be non-weighted throughout the EEU whereby each grid cell within a nesting habitat or EEU receives equal consideration, or distribution can be weighted on the basis of the natural distribution tendencies of the animal if distribution data are available. At LANL, land cover types, including classes of animal habitat, have been determined from aerial data and the data have been ground-verified. Given a specification of the total number of nest sites for each execution (“run”) of ECORSK.7 (ECORSK.7 can manage up to 5000), the number of nest sites/focal points for each habitat type can be weighted on the basis of density or abundance data. While the relative weight of each habitat type is based on the proportion of total weight made up by each habitat type, it is also intersected with the proportion of the total EEU made up by a given habitat type. For example, if the abundance of the Western bluebird on piñon-juniper woodlands is three times the abundance on grasslands, three times as many nest sites would have been assigned to piñon-juniper as to



NOTE: LOAEL = low observed adverse effects level; NOAEL = no observed adverse effects level.

Figure 2. Schematic of strategy for integrating FORTRAN95 code with GIS and analytical data.

grasslands <u>only</u> <u>if</u> there were equal relative amounts (areas) of piñon-juniper and grasslands in the area being assessed (EEU). In reality there are unequal amounts of area in the various habitat types, therefore the abundance weighting is interacted against the relative proportion of total area made up by each of the habitat types (piñon-juniper, grasslands, etc.). The weightings also affect simulated foraging (or occupancy) as discussed later.

The following relationship was used to obtain the number of nest sites/focal points per land cover class:

$$S_i = N \times G_i / \sum_{j=1}^{n} G \quad ,$$

where

S_i = number of nest sites/focal points selected from the i^{th} habitat food utilization factor, e.g., 1.5, 3.6, 4.5…G_n,
N = total number of nest sites/focal points randomly generated in the run,
G_i = value of the i^{th} habitat food utilization factor,
n = total number of habitat food utilization factors employed (10 maximum), and
j = number of COPECs.

Thus, the sum of all S_is is equal to the specified total number of nest sites/focal points specified (e.g., 1000), and, if they are generated randomly, the selection occurs without replacement.

Simulated Foraging Process

Beginning at any given nest site (grid cell), if the HR of an animal is larger than one grid cell, ECORSK begins the selection of grid cells in a concentric fashion around the nest site and continues until the HR of an animal is reached. If the model cannot complete its development of the HR in any direction because it encounters a pre-defined boundary (e.g., the south Los Alamos and Pueblo Canyons watershed boundary), it adds to the HR in other directions until the HR is complete. Foraging outside the pre-defined EEU does not occur. The model iterates this process for the specified number of nest sites/focal points for a receptor, e.g., 1000 for the deer mouse and bluebird; 100 for the owl. For each nest site ECORSK.7 calculates HIs and hazard quotients (HQs) as discussed below.

Distance-Weighted Foraging. In the application of the model described by this report only the Mexican spotted owl had a HR sufficiently large to apply an exponential function as described in this subsection. The assumption can be made that the relative probability of foraging is inversely related to the radial distance from the animal's nest site, roosting area, or other focal point and mathematically this can be expressed through the use of an exponential function:

$$O_i = A_i/\sum A_i \, ENH_i \;\; \mathrm{Exp}\,(-R_i/R_c) \, ,$$

where

O_i = occupancy factor for any grid cell (i) of an EEU,
A_i = surface area, km^2, of the i^{th} grid within the HR of a given animal,
ENH_i = enhancement factor,
R_i = radial distance, m, of the i^{th} grid from the grid center containing the nest site, and
R_c = a scaling constant, m, for a given species.

A scaling constant of 350 m was estimated from Johnson (1993) for the Mexican spotted owl. Application of this function results in almost 75% of the foraging within 1 km of a nest site. Distance-weighted foraging was used only for the owl. Scaling constants for non-avian species with large HRs can be obtained in a similar manner.

Habitat-Weighted Foraging. ARC/INFO was used to integrate land cover/topography with species-weighted distribution data across the study area. The relative density or abundance data mentioned previously in discussion of nest site selection also can affect the foraging process during calculation of HQs and HIs if this option is selected. From field data collected at LANL, absolute measures of density or abundance were converted to the relative values shown in Table 1 (a, b, c). Relative values are associated with the integer values that are used as map codes by ECORSK.7 to give every grid cell an identifier that is associated with a particular weighting (relative value) when the model is executed. HI/HQ output data are populated using the density/abundance data such that, for example, in essence 12.35 deer mice will forage in grid cells occupied by ponderosa pine mesas for every one deer mouse that forages in grid cells with wetlands/riparian habitat. Impact associated with ranges of HIs can be applied to populations of a species by equating HI frequency distributions with proportions of populations impacted. With a spatial distribution of HIs, HI contours can then be applied to address population risk by geographical area.

Density for deer mouse was calculated by land cover and topography (mesa top or canyon bottom). To develop the deer mouse EEU spatial layer, we first intersected (using ARC/INFO INTERSECT command) the land cover layer with the canyon-mesa top layer to produce a composite layer with land cover attributes and canyon and mesa top attributes. We coded this new layer with the relative importance values derived from the average density information. These values are listed in Table 1a.

Distribution of the Mexican spotted owl was based on the suitability of three general habitats (Table 1b) to be consistent with methods used for protecting the owl as described in the Habitat Management Plan for LANL (LANL 1998). Habitats are designated as Core area, Buffer area, or Extraneous and the relative difference in weighting is 100, 10, and 1, respectively. The relative differences in habitat suitability were determined using a topographic model. Potential nesting/roosting zones were based on work performed by Johnson (1993) in which he developed a topographic model to rate the physical potential of habitat for breeding spotted owls. Topographic data of the U.S. Geological Survey provided the input for modeling the potential habitat. Historical owl locations were extracted from a New Mexico Department of Game and Fish database prepared by the New Mexico Natural Heritage Program. The model was developed by examination of topographic characteristics of owl locations and random locations to find a scalar function of topography that quantitatively separated inhabited areas from random locations. The database included 1383 records of historical reports and U.S. Forest Service inventory and monitoring daytime follow-up field work through 1991. See Johnson (1993) for more detail on the methodology for identifying potential owl nesting habitat.

Relative abundance of bluebirds by land cover type was estimated (Table 1c) from 2002 field data on presence and absence, which was collected from a total of 561 boxes placed throughout LANL (Fair and Sommer 2003). Abundance was estimated on the basis of proportion of total presence-count made up by presence-count in each land cover type. Bluebirds typically invade burned areas in response to increases in invertebrate populations, so a higher abundance in areas burned by the Cerro Grande Fire might have been expected. However, competition by other bird species may have slowed the re-establishment of bluebirds in the burned areas. Also, years of drought on the Pajarito Plateau may have compounded the effect of the fire such that recovery of the burned ecosystems may be retarded.

Table 1a. Relative Importance Values and Weighting of Land Cover Types for Deer Mouse

Land Type	Average Density (No./ha)	Relative Density (Weight)	Assigned Map Code Integer/ Grid Values	No. Grid Cells in Study Area	No. Grid Cells With Sample Value Data
Wetlands/Riparian/Water	3.4	1.0	100	102	81
Piñon-Juniper-Mesas	4.0	1.17	120	4585*	127*
Piñon-Juniper-Canyon	6.0	1.76	180	16,008**	1355**
Bare Ground Areas	4.0	2.64	120	4585*	127*
Deciduous/Aspen/Oak	6.0	1.76	180	16,008**	1355**
Ponderosa Pine Canyons	6.0	1.76	180	16,008**	1355**
Ponderosa Pine Mesa	42.0	12.35	1240	2411	63
Grasslands	9.0	2.64	260	486***	56***
Juniper Woodlands	9.0	2.64	260	486***	56***
Mixed Conifer	11.0	3.26	320	645	35
Disturbed Areas	16.0	4.7	470	7648	167

*Split among the two land cover types with this grid value.
**Distributed among the three land cover types with this grid value.
***Split among the two land cover types with this grid value.

Table 1b. Relative Importance Values and Weighting of Land Cover Types for Mexican Spotted Owl

Land Type	Absolute Preference	Relative Preference (Weighting)	Assigned Map Code Integer Values	No. Grid Cells in Study Area	No. Grid Cells With Sample Value Data
Outside Core and Buffer, Within Study Area	1.0	1.0	1	15,359	613
Buffer Zone	10.0	10.0	10	7114	427
Core Area	100.0	100.0	100	10,945	850
Outside Watershed	0.0	0.0	0	0	0

Table 1c. Relative Importance Values and Weighting of Land Cover Types for Western Bluebird

Land Type	Absolute Abundance	Relative Abundance (Weighting)	Assigned Map Code Integer Values	No. Grid Cells in Study Area	No. Grid Cells With Sample Value Data
Burned	0.03	1.0	3	1155*	4*
Open Water	0.00	0.0	0	145**	14**
Urban-Sparse-Bare Rock	0.09	3.0	9	7527	189
Grass Species	0.06	2.0	6	170	6
Shrub Species	0.18	6.0	18	1885	199
Piñon-Juniper	0.33	11.0	33	17,276	639
Ponderosa Pine	0.27	9.0	27	6758	861
Mixed Conifer/Spruce-Fir	0.00	0.0	0	145**	14**
Aspen/Riparian/Wetland	0.03	1.0	3	1155*	4*

*Split among the two land cover types with this grid value.
**Split among the two land cover types with this grid value.

The EPAQM

The EPAQM, or some variation of it, has been frequently applied in the past decade in screening level and more sophisticated ecological risk assessments. The HQ is a ratio between exposure and an effect level (as represented by a toxicity reference value [TRV]), which can be used as a potential indicator of effects. The HI is defined as the sum of HQ values for COPECs with common toxicological effects. If the HQ/HI are greater than 1.0, then this is an indication of the potential for adverse ecological effects.

The following equations are simplified versions of how the HQ and HI are calculated, and are discussed in the Ecological Risk Assessment Guidance for Superfund (USEPA 1997):

$$HQ_{ij} = \frac{exposure\ level}{effect\ level\ (or TRV)} \qquad \text{and} \qquad HI_i = \sum_{j=1}^{n} HQ_{ij} \ ,$$

where

HQ_{ij} = hazard quotient for receptor i to COPEC j (unitless),
exposure level = exposure dose received by the animal receptor (units are mg of COPEC per kg body weight of the exposed animal per day or mg/kg/day),
effect level = effect level (represented by TRV) for exposure to COPEC j for receptor i (mg/kg/day),
and HI_i = hazard index for receptor i for n (all) COPECs (unitless).

The mean total HI is the arithmetic average of HIs for a specified total number of nest sites established for a receptor—1000 for the deer mouse and bluebird and 100 for the owl—totaled across all COPECs. The more detailed calculation of HIs is discussed below.

Although HQs for all classes of COPECs (radionuclides, nonradionuclide metals, and organic chemicals) are summed into one HI, we discuss their derivation separately.

For nonradionuclides,

$$HI = Food \times (Soilf + BCF) / Bodwt \times \sum_{j=1}^{ncs} Occup_j \sum_{l=1}^{ncoc} Dc_{j,l} / TRV_l \ ,$$

where

HI = hazard index (cumulative HQ for all COPECs),
Food = amount of food consumed by a given animal, kg/day,
Soilf = fraction of diet comprised of soil,
BCF = bioconcentration factor (transfer factors from Ecorisk Database R2.0, LANL 2003), where the BCF is used in a manner that soil-to-receptor and food chain transfer of contaminants are included in the HI calculation;
$Occup_j$ = occupancy factor on the j^{th} contamination site,
$Dc_{j,l}$ = concentration of COPEC in soil (mg COPEC/kg soil) for the j^{th} contamination site (exposure dose) of the l^{th} COPEC,
TRV_l = consumed dose above which observable adverse effects may occur, mg-COPEC/kg-body weight-day of the l^{th} COPEC,
ncs = number of contaminated sites, and
ncoc = number of contaminants in the j^{th} contamination site.

For radionuclides, effects levels (TRVs) have been back-calculated to concentrations in soil (ecological screening levels [ESLs], defined below) so the derivation of HIs for radionuclides is simplified as

$$HI = \sum_{j=1}^{ncs} Occup_j \sum_{l=1}^{ncoc} SC_{j,l} / (ESL_l \times ESL_{a_l}) \ ,$$

where

HI = hazard index (cumulative HQ for all COPECs),
$SC_{j,l}$ = soil concentration of COPEC, pCi-COPEC/kg-soil for the j^{th} contamination site of the l^{th} COPEC,
ESL_l = ecological screening level, pCi COPEC/kg soil of the l^{th} COPEC,
$ESLa_l$ = adjustment factor for ESL_l above for the l^{th} COPEC,
$Occup_j$ = occupancy factor on the j^{th} contamination site,
ncs = number of contamination sites, and
ncoc = number of contaminants in the j^{th} contamination site.

The derivation of ESLs is described in a LANL report titled Screening Level Ecological Risk Assessment (LANL 1999).

A cumulative HQ across all COPECs, or HI, assumes that sublethal doses of various contaminants are additive in their effect, rather than synergistic, antagonistic, or independent. Although HQs for all classes of COPECs (radionuclides, nonradionuclide metals, and organic chemicals) are summed into an HI, the output files are such that HQs can be easily separated on any basis, such as radionuclides from nonradionuclides, and then summed into HIs by class of contaminant.

Approach

The ECORSK model was designed to contribute to or comprise a Tier 2 level of assessment, which generally is more realistic than screening assessments. For example, arithmetic mean COPEC sample values and background concentrations were used rather than maximum values or upper tolerance limits. Geometric mean (GMM) values were used for the baseline scenario rather than minimum TRVs. Actual animal distribution data were used and their natural HR tendencies were simulated rather than artificially restricting their distribution to a contaminated area.

Risk Sources

ECORSK.7 computes HIs and HQs for risk associated with three source-types: unadjusted, background, and adjusted.

Unadjusted. This source type is a quantified total HI/HQ associated with anthropogenic and background levels of COPECs. Mathematically, unadjusted HIs are the sum of "background" plus "adjusted" HIs. Source COPEC values are 1) sample values that have been entered into the HQ formula, making no distinction between anthropogenic and background concentrations; 2) in sampled grid cells where COPEC sample values are less than background values, then the sample value is entered into the HQ formula; and 3) in unsampled grid cells, mean COPEC background values are entered. The unadjusted mean total HI in this report is the arithmetic average of HIs for a specified total number of nest sites established for a receptor—1000 for the deer mouse and bluebird and 100 for the owl—totaled for all COPECs.

Background. This source type is a quantified HI associated with "natural" (nonradionuclides) and "regional" (radionuclides) non-Laboratory sources of COPECs. The mean natural or regional background soil or sediment concentration is entered into the HQ formula. Natural is distinguished from regional because radionuclide background values exist from sources other than LANL (e.g., atmospheric fallout).

Adjusted. This source type is a quantified HI/HQ for risk associated with "Lab-added" concentrations of COPECS. Although regional sampling has shown that there are measurable concentrations of organic COPECs upslope and upwind of LANL, on a practical level we did not use a background value for organics in the "Baseline Scenario," therefore, while all of the modeled risk associated with organics is ascribed to LANL sources, in reality some of it is from non-LANL sources.

Thus, mathematically,

Unadjusted Risk = Lab-Added Risk + Background Risk,

and

Adjusted Risk ("Lab-Added") = Total Risk – Background Risk.

HI/HQ Breakdown. Several different HIs and HQs are generated by ECORSK, varying in the degree of summarization or breakout that is represented by a value. The mean total HI, a single value representing the mean of HIs for all nests and summed for all COPECs, is the most summarized value and is generated for each execution of ECORSK. For example, if 1000 nest sites were selected for a given model execution (or run), then a single value, the grand mean total HI (in *OUTRSK.DAT*), would be the mean of 1000 HIs (actually partial HIs [pHIs]) (in *HQ.DAT*). This value assumes that all classes of COPECs—organic, metal, and radiological—have common toxicological effects; however, breakouts by COPEC enable the user to sum HIs and HQs by any particular grouping of COPEC. Numerous breakdown (or "roll-out") values beyond the mean total HI and pHIs are generated by ECORSK. The HI for one nest site (in a total of, say, 1000) would result from the sum of the HQs for each COPEC for each grid cell in the HR. The 1000 sets of HQs (summed within a HR) by COPEC are output in *HQP.DAT*. Thus far we have discussed "sink" values that are derived from break-out or "source" values. The ECORSK output in its rawest (most broken down) form consists of "source" values—values that contribute toward the "roll-up" values; i.e., source values consist of an HQ for each COPEC of each grid cell within an HR that was summed to result in a *HQP.DAT* value; e.g., if a HR consisted of 3500 grid cells for a given species and all 3500 cells had a sample value for, say Aroclor-1254, and 1000 nest sites were specified and every grid cell surrounding every nest site had a sample value for Aroclor-1254, then ECORSK would output into *HQPC.DAT* 1000 sets of 3500 partial HQs for Aroclor-1254 alone, or 3,500,000 total source HQs for each execution of ECORSK. Thus, the raw output can get quite lengthy. The mathematical representations of these outputs have been documented in detail in a report by Gallegos and Gonzales (1999).

The LANL RRES-RS Project uses a HQ value of 0.3 to identify COPECS (LANL 1999). The RRES-RS Project is responsible for evaluating PRSs under the RCRA Corrective Action Program and formally identifying COPECs. In this report, COPECs with receptor average HQ values greater than 0.3 will be listed and discussed.

Contaminant Data

Updated contaminant data sources for the ECORSK model included measured sediment concentrations, interpolated sediment concentrations, and measured data from the SWEIS database. The focus of these runs of the ECORSK model was to evaluate the potential for adverse ecological risks associated with COPECs in canyon sediments. This information will be used as one of the lines of evidence for evaluating ecological risks associated with contaminants in Los Alamos and Pueblo Canyons sediments (Katzman 2002). The data from the SWEIS database provide information on COPEC sources in the Los Alamos and Pueblo Canyons watershed. Concentrations in the canyons sediment and the concentrations in source areas (PRSs) are used for evaluating the potential for population effects on ecological receptors with relatively small HRs (deer mouse and bluebird) and for evaluating risks for individuals with large HRs (Mexican spotted owl). Although the sampled material in the canyons is geologically termed "sediment," it primarily supports a terrestrial ecological community and the ECORSK model is used as one of the lines of evidence to evaluate ecological effects on populations or individuals of terrestrial ecological receptors. The potential for adverse ecological effects on aquatic receptors will be evaluated with other lines of evidence.

Measured Canyons Contaminant Data. The canyons COPEC database was obtained from the ER Project data base for use in LAPCIR. Most of these data have been reported in six previously published reports on sediments in the Los Alamos and Pueblo Canyons watershed (Katzman et al. 1999; Reneau et al. 1998a, b, c; 2000; 2002). These reports describe the results of phased, geomorphic investigations of post-1942 sediment deposits in sections of canyon bottoms called "reaches." The reaches were located based on information on contaminant sources, available historic sediment data, and the conceptual model of contaminant redistribution (LANL 1995, 1997). These investigations used geomorphic surveys, radiation field screening measurements, and analytical laboratory data to refine the conceptual model and provide information on the nature and extent of COPECs in canyon-bottom sediment deposits.

Comparison of the maximum concentrations reported for sediment samples in the measured Los Alamos and Pueblo Canyons data to ESLs identified 52 COPECs (Table 2). Seven COPECs were eliminated because the maximum concentration in the sediment data was either from removed samples (removed in remedial or cleanup actions) or baseline (upstream from LANL effluent contaminant sources) ash-rich samples collected after the Cerro Grande Fire.

Canyon sediments are temporally dynamic due to ongoing erosion and deposition. In canyons downstream of Cerro Grande Fire burned watersheds, rates of deposition and erosion were greatly accelerated. Ash-laden sediment contains elevated concentrations of certain metals, organics, and radionuclides (Kraig et al. 2002). Some of the post-fire sediment sampling results for Los Alamos and Pueblo Canyons were included in the data sets that served as input to ECORSK.7. Therefore, fire impact is included in this assessment.

For the Preliminary Baseline Scenario, some data were qualified as "not detected" and for the measured contaminant data set we replaced non-detects with the detection limit (DL). Replacement of non-detects with the DL or some proportion of the DL is a commonly used technique and whether or not this method is practiced and the value used should depend on the particular objectives of an assessment (Gilbert 1987). Use of the DL as the replacement value rather than one-half the DL or '0' is the most conservative. The DL was used to be consistent with how non-detected sample results were handled in the SWEIS database, which is discussed below. Substituting the DL for the non-detected sample results is the most protective replacement value, and the possible effects of this assumption will be evaluated when interpreting the results of the model. As discussed in the section below, replaced values and

Table 2. List of COPECs in Canyons Sediment and those Retained for ECORSK.7 Model

Suite	COPEC	Retained	Rationale
Inorganic	Aluminum	No	Eco-SSL* is not a COPEC unless pH<5.5
Inorganic	Antimony	Yes	HQ>0.3 for maximum
Inorganic	Arsenic	Yes	HQ>0.3 for maximum
Inorganic	Barium	Yes	HQ>0.3 for maximum
Inorganic	Beryllium	Yes	HQ>0.3 for maximum
Inorganic	Boron	Yes	HQ>0.3 for maximum
Inorganic	Cadmium	Yes	HQ>0.3 for maximum
Inorganic	Chromium	Yes	HQ>0.3 for maximum
Inorganic	Cobalt	Yes	HQ>0.3 for maximum
Inorganic	Copper	Yes	HQ>0.3 for maximum
Inorganic	Cyanide, Total	Yes	HQ>0.3 for maximum
Inorganic	Lead	Yes	HQ>0.3 for maximum
Inorganic	Manganese	Yes	HQ>0.3 for maximum
Inorganic	Mercury	Yes	HQ>0.3 for maximum
Inorganic	Methyl mercury	Yes	HQ>0.3 for maximum
Inorganic	Nickel	Yes	HQ>0.3 for maximum
Inorganic	Selenium	Yes	HQ>0.3 for maximum
Inorganic	Silver	Yes	HQ>0.3 for maximum
Inorganic	Thallium	Yes	HQ>0.3 for maximum
Inorganic	Titanium	Yes	HQ>0.3 for maximum
Inorganic	Uranium, Total	Yes	HQ>0.3 for maximum
Inorganic	Vanadium	Yes	HQ>0.3 for maximum
Inorganic	Zinc	Yes	HQ>0.3 for maximum
PAH*	Acenaphthene	Yes	HQ>0.3 for maximum
PAH	Benzo(a)anthracene	Yes	HQ>0.3 for maximum
PAH	Benzo(a)pyrene	Yes	HQ>0.3 for maximum
PAH	Benzo(b)fluoranthene	Yes	HQ>0.3 for maximum
PAH	Benzo(g,h,I)perylene	Yes	HQ>0.3 for maximum
PAH	Chrysene	Yes	HQ>0.3 for maximum
PAH	Fluoranthene	Yes	HQ>0.3 for maximum
PAH	Fluorene	Yes	HQ>0.3 for maximum
PAH	Naphthalene	Yes	HQ>0.3 for maximum
PAH	Phenanthrene	Yes	HQ>0.3 for maximum
PAH	Pyrene	Yes	HQ>0.3 for maximum
PCB*	Aroclor-1248	No	Only detect was in removed ACS* samples
PCB	Aroclor-1254	Yes	HQ>0.3 for maximum
PCB	Aroclor-1260	Yes	HQ>0.3 for maximum
Pesticide	DDE(4,4'-)	Yes	HQ>0.3 for maximum
Pesticide	DDT(4,4'-)	Yes	HQ>0.3 for maximum
Pesticide	Dieldrin	Yes	HQ>0.3 for maximum
Pesticide	Endrin	Yes	HQ>0.3 for maximum
Radionuclide	Americium-241	Yes	HQ>0.3 for maximum
Radionuclide	Cesium-137	Yes	HQ>0.3 for maximum
Radionuclide	Plutonium-238	No	Only HQ>0.3 in ACS removed samples
Radionuclide	Plutonium-239,240	Yes	HQ>0.3 for maximum
Radionuclide	Thorium-232	Yes	HQ>0.3 for maximum
Radionuclide	Uranium-234	No	Only HQ>0.3 in ACS removed samples
Radionuclide	Uranium-238	No	Only HQ>0.3 in ACS removed samples
SVOC*	Benzoic_Acid	Yes	HQ>0.3 for maximum
SVOC	Bis(2-ethylhexyl)phthalate	Yes	HQ>0.3 for maximum
SVOC	Phenol	No	Only detected in post-fire baseline samples
SVOC	Tetryl	No	Only detected in post-fire baseline samples

* eco-SSL = ecological soil screening levels; PAH = polyaromatic hydrocarbon; PCB = polychlorinated biphenyl; SVOC = semivolatile organic compound; ACS = Acid Canyon, South Fork.

measured values were used to predict (interpolate) contaminant concentrations at locations where contamination is known to exist but where sampling has not occurred. Radionuclide sample results were not censored at the DL and negative values were accepted, thus the measured canyons contaminant data included the uncensored radionuclide results.

Interpolation of Measured Canyons Contaminant Data. At canyon inter-reach locations where contaminants were not measured but are known to exist at levels above background based on an understanding of contaminant dispersion during floods, analyte concentrations were interpolated (predicted) from the measured concentrations that are available for reaches that have been investigated. As was mentioned in the previous section, interpolated values were derived from both measured concentrations and from replaced values, so as with the measured contaminant data set the interpolated set was protective. Our interpolation data were reach averages of measured canyons sediment samples as was discussed above. These data were collected with detailed geomorphic unit descriptions to enable precise characterization of COPEC distributions. Our analysis required predicted analyte concentrations in areas where detailed geomorphic unit information was not available, so other information was used for the interpolated values.

Prior reports (Katzman et al. 1999; Reneau et al 1998a, b, c; 2000; 2002) show that there are general spatial trends in the sediment data. For a single source and down-gradient attenuation of a marker substance in canyon sediments, one useful interpolation model is $\log(concentration) = \alpha + \beta \cdot x$, where x is distance from the source and α and β are estimated from the measured data. We also evaluated a simple linear regression of concentration versus distance. The model with the larger coefficient of determination (r^2) was selected to interpolate the inter-reach concentrations. If there were no significant concentrations trends then the average concentration in the subwatershed was used as the estimate of the analyte in the between reach grid cells. For Los Alamos Canyon we substituted distance (kilometers) from the Rio Grande measured along the active channel. One factor affecting analyte concentrations is the input of sediments from an adjacent subwatershed, such as when DP Canyon empties into Los Alamos Canyon. If the tributary canyon has low concentrations of the analyte, then concentrations can sharply decrease at the confluence. Concentrations can also sharply increase if higher concentrations exist in the tributary compared to the main canyon drainage. The trend plots were inspected for such discontinuities, and information on nature and sources of contamination from the prior reports were also instructive in establishing interpolation models with a sound basis.

Sediment texture is another factor affecting concentrations of analytes. However, for these interpolations variations in concentration based on texture were not evaluated. Instead it was assumed that texture does not vary sufficiently across the watershed for texture to make a significant difference in the exposure concentrations for wildlife receptors or wildlife populations. We evaluated reach averages for spatial trends as reaches represent the most ecologically relevant spatial scale for wildlife receptors and populations.

The interpolations models and the code used to generate the data file for importing into the EEUINP file are provided in Appendix Table A-1.

SWEIS Database. These data include soil and sediment data compiled from contaminant data tables in Appendix C of the SWEIS (USDOE 1999). These data were used in an assessment in 2000 and details on these data and the query used to compile these data can be found in a report by Gonzales et al. (2002). The SWEIS data were used to supplement the measured and interpolated canyons sediment sample results for the 45 COPECs retained for use in ECORSK.7. The SWEIS data are needed to evaluate potential impacts of COPECs on populations of wildlife receptors (deer mouse and bluebird) or impacts on individuals of species with large HRs

(Mexican spotted owl). Because the SWEIS data include sample results only through 1998, there has been additional characterization of contaminant source areas since that time. There have also been some remediation projects implemented since 1998 that are not reflected in these data. Thus, there is uncertainty regarding the SWEIS data, which is why it is used only to supplement the canyons measured and interpolated data. Results of the ECORSK model will be interpreted relative to the better-documented contaminant data (canyons) versus the more uncertain data.

Summary of COPEC Data

This section describes the information, mostly model input data, that was used for Scenario 3 model executions.

EEUINP.DAT Summary Data. Table 3 contains summary statistics used to create the major input file (eeuinp.dat) to ECORSK.7 for the baseline scenarios—Scenarios 3a–3c (discussed later). COPEC sample value summary statistics (average, maximum, minimum) as well as a corresponding background value are listed for each analyte. The tables also contain the TRV and weighted bioconcentration factors (BCFs) associated with a particular analyte for a particular screening receptor. We use the term TRV generically and it can refer to a level of a contaminant in animal tissue such as a no-observed-adverse-effects level (NOAEL) or a level in soil such as an ESL. TRVs for nonradionuclides are derived based on a tiered TRV development process, which is discussed in more detail in the following paragraph. TRVs for radionuclides are calculated based on ESL models, which are described in more detail on page 23. Weighted BCFs were required because the screening receptors modeled had diets of mixed composition (plant and invertebrate components or invertebrate and flesh components). The weighted BCF for each analyte for each screening receptor was calculated using the following equation:

$$BCF_{wtd} = (BCF_{\text{soil to dietary component 1}} * f_{\text{dietary component 1}}) + (BCF_{\text{soil to dietary component 2}} * f_{\text{dietary component 2}}) ,$$

where f represents the fraction of the diet that the dietary component represents. The BCF is used in the HI and HQ formulae in a manner that both soil-to-receptor and food chain transfer are modeled.

Documentation for Nonradionuclide TRVs. Table 4 (a and b) has details on the derivation and selection of the TRVs for the birds (Western bluebird and Mexican spotted owl) and for the mammal (deer mouse). Table 4 (a and b) reports the nonradionuclide TRVs and their data types and data sources. All the nonradionuclide TRVs are from the LANL RRES-RS Project Ecorisk Database R2.0 ("Ecorisk Database R2.0") (LANL 2003) and are developed using a tiered TRV development process implemented by the project in 2003. There are four tiers of TRVs with a Tier 1 TRV being the most preferred value because it is a nationally accepted value such as the EPA eco-SSLs. A Tier 2 TRV is the next preference and is equal to a GMM TRV, which is derived by calculating the GMM of three or more Primary Toxicity Study Evaluation (PTSE) process-derived TRVs for ecologically relevant endpoints of reproduction, development, survival, or adult weight changes. The PTSE process is described in more detail under the Tier 3 TRV description in the Database. The Tier 3 TRV is third in the hierarchy of preference and is equal to a Critical Study (CS) TRV derived using the PTSE process. The PTSE process was developed and implemented by LANL RRES-RS and consists of 1) the extraction of data relevant for deriving TRVs from primary toxicity literature, 2) the evaluation or scoring of the study based on relevance to deriving TRVs for ecological receptors, 3) the calculation of Primary Toxicity Values (PTVs) for any ecologically relevant endpoints whose results were reported in the literature, 4) the normalization of the PTVs to chronic NOAELs using uncertainty factors as required to extrapolate from less-than-chronic to chronic exposure durations or from

Table 3. Eeuinp.dat Summary Data for the Three Receptors Modeled Using ECORSK.7

Analyte Group	Analyte	Analyte Code	Average Sample Value	Minimum Sample Value	Maximum Sample Value	Background Sediment Mean	Western Bluebird		Mexican Spotted Owl		Deer Mouse	
							TRV	BCF	TRV	BCF	TRV	BCF
Inorganic	Antimony	SB	2.52	0.03	181	0.505					0.06	0.6
Inorganic	Arsenic	AS	2.53	0.11	260.6	1.84	5.14	0.598	5.14	0.08	0.126	0.35
Inorganic	Barium	BA	166.1	8.6	38000	60.4	73.5	0.915	73.5	0.12	52	0.575
Inorganic	Beryllium	BE	0.976	0.07	146.7	0.59					0.53	0.505
Inorganic	Boron	B	1.91	1.2	6.4	1.4	2.92	1.3	2.92	0.121	28	2.5
Inorganic	Cadmium	CD	1.89	0.01	1540	0.093	1.7	5.17	1.7	0.69	0.77	3.03
Inorganic	Chromium (total)	CR	5.68	1.2	20.4	5.62	26.6	0.055	26.6	0.007	22.96	0.034
Inorganic	Cobalt	CO	3.81	0.33	255.34	2.35	7.6	0.902	7.6	0.132	7.3	0.51
Inorganic	Copper	CU	87.3	0.83	38801.6	4.57	2.98	0.256	2.98	0.03	5.13	0.32
Inorganic	Cyanide (total)	CN (-1)	0.57	0.05	66.8	0.295	0.04	1	0.04	0.351	68.7	1
Inorganic	Lead	PB	66.12	1.5	66223	9.25	1.6	0.167	1.6	0.022	5.8	0.113
Inorganic	Manganese	MN	324.9	65.1	1500	290	581	0.313	581	0.038	44	0.285
Inorganic	Mercury	HG	0.626	0.002	258.9	0.012	0.019	0.22	0.019	0.065	1.41	0.139
Inorganic	Mercury (methyl)	HGM	0	0.00001	0.002	0	0.006	45.9	0.007	13.5	0.032	25.6
Inorganic	Nickel	NI	10.7	1.2	1200	4.98	21.9	0.111	21.9	0.015	43.9	0.076
Inorganic	Selenium	SE	1.29	0.07	361	0.1	0.44	0.902	0.44	0.129	0.2	0.508
Inorganic	Silver	AG	3.12	0.024	410	0.066	5.44	0.94	5.44	0.122	19	0.7
Inorganic	Thallium	TL	1.03	0.02	121.3	0.276					0.007	0.502
Inorganic	Titanium	TI	256.4	88.8	1840	242					15.8	0.503
Inorganic	Uranium (total)	U (total)	4.31	1.1	11.3	3.76	78	0.901	78	0.12	6.1	0.504
Inorganic	Vanadium	V	12.9	0.845	238.9	10.4	1.1	0.901	1.1	0.12	2.1	0.503
Inorganic	Zinc	ZN	65.5	7.35	4979.2	33.9	37.7	3.21	37.7	0.61	126	2.45
Organic	Acenaphthene	83-32-9	0.64	0.015	40.5	0					70	1.32
Organic	Aroclor-1254	11097-69-1	0.13	0.002	21.3	0	0.1	6.13	0.1	4.67	0.611	3.45
Organic	Aroclor-1260	11096-82-5	0.187	0.003	65.5	0	2.15	6.13	2.15	4.9	13.8	3.45
Organic	Benzo(a)anthracene	56-55-3	1.13	0.026	160	0					0.17	0.155
Organic	Benzo(a)pyrene	50-32-8	1.05	0.04	130	0					1	0.255

Table 3. cont.

Analyte Group	Analyte	Analyte Code	Average Sample Value	Minimum Sample Value	Maximum Sample Value	Background Sediment Mean	Western Bluebird		Mexican Spotted Owl		Deer Mouse	
							TRV	BCF	TRV	BCF	TRV	BCF
Organic	Benzo(b)fluoranthene	205-99-2	1.27	0.036	200	0					4	0.252
Organic	Benzo(g,h,I)perylene	191-24-2	0.863	0.002	120.9	0					7.2	1.4
Organic	Bis (2-ethylhexyl) phthalate	117-81-7	0.991	0.038	83.5	0	1.1	2.69	1.1	5.92	18.3	1.49
Organic	Chrysene	218-01-9	1.28	0.031	190	0					0.17	0.185
Organic	DDE[4,4'-]	72-55-9	0.01	0.001	0.607	0	0.086	6.76	0.086	9.33	10	3.78
Organic	DDT[4,4'-]	50-29-3	0.015	0.001	0.659	0	0.24	6.76	0.24	7.68	1.07	3.78
Organic	Dieldrin	60-57-1	0.008	0.001	0.2	0	0.079	2.14	0.079	0.992	0.015	1.27
Organic	Endrin	72-20-8	0.009	0.001	0.605	0	0.01	2.08	0.01	0.783	0.092	1.26
Organic	Endrin Aldehyde	7421-93-4	0.008	0.00033	0.2	0	0.01	2.08	0.01	0.783	0.092	1.26
Organic	Fluoranthene	206-44-0	2.03	0.038	320	0					12.5	1.25
Organic	Fluorene	86-73-7	0.639	0.017	36.9	0					125	1.28
Organic	Naphthalene	91-20-3	0.631	0.002	26.6	0	0.014	1.79	0.014	0.307	0.5	1.46
Organic	Phenanthrene	85-01-8	1.52	0.027	177.9	0					5.14	1.26
Organic	Pyrene	129-00-0	2.02	0.035	280	0					7.5	1.26
Radionuclide	Americium-241	AM-241	1.43	-0.227	301.2	0.026	41	0	130	0	32313.7	0
Radionuclide	Cesium-137	CS-137	4.25	-0.121	657.8	0.211	130	0	14	0	2415.5	0
Radionuclide	Plutonium-239, 240	PU-239/240	4.32	0	832.2	0.025	20	0	55	0	151353.1	0
Radionuclide	Thorium-232	TH-232	1.55	0.053	15.2	1.43	2.7	0	7.3	0	29032.7	0

Table 4a. Details of Nonradionuclide TRVs for Bird Receptors

Analyte	Analyte Code	TRV	Units	Data Type*	Data Source**	Surrogate Analyte
Arsenic	AS	5.14	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Barium	BA	73.5	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Boron	B	2.92	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Cadmium	CD	1.7	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Chromium (total)	CR	26.6	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Cobalt	CO	7.6	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Copper	CU	2.98	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Cyanide (total)	CN(-1)	0.04	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Lead	PB	1.6	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Manganese	MN	581	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Mercury	HG	0.019	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	Mercury (Inorganic)
Mercury (methyl)	HGM	0.006	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Nickel	NI	21.9	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Selenium	SE	0.44	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Silver	AG	5.44	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Uranium (total)	U (total)	78	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	Uranium
Vanadium	V	1.1	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Zinc	ZN	37.7	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Aroclor-1254	11097-69-1	0.1	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Aroclor-1260	11096-82-5	2.15	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	

Table 4a. cont.

Analyte	Analyte Code	TRV	Units	Data Type*	Data Source**	Surrogate Analyte
Bis(2-ethylhexyl)phthalate	117-81-7	1.1	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
DDE[4,4'-]	72-55-9	0.086	mg/kg/d	Chronic subset GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
DDT[4,4'-]	50-29-3	0.24	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Dieldrin	60-57-1	0.079	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Endrin	72-20-8	0.01	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Endrin Aldehyde	7421-93-4	0.01	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	Endrin
Naphthalene	91-20-3	0.014	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	

*CS stands for Critical Study. GMM stands for Geometric Mean. NOAEL stands for No Observed Adverse Effect Level.
** ECORDBR2.0NOV03 stands for Release 2.0 of the LANL RRES-RS Project Ecorisk Database (LANL 2003). LANL stands for Los Alamos National Laboratory. ORNL stands for Oak Ridge National Laboratory. EPA EcoSSL stands for the U.S. Environmental Protection Agency Ecological Soil Screening Level Methodology.

Table 4b. Details of Nonradionuclide TRVs for Mammal Receptors

Analyte	Analyte Code	TRV	Units	Data Type*	Data Source**	Surrogate Analyte
Antimony	SB	0.06	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Arsenic	AS	0.126	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Barium	BA	52	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Beryllium	BE	0.53	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Boron	B	28	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Cadmium	CD	0.77	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Chromium (total)	CR	22.96	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Cobalt	CO	7.3	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Copper	CU	5.127	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Cyanide (total)	CN(-1)	68.7	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Lead	PB	5.8	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	

Table 4b. cont.

Analyte	Analyte Code	TRV	Units	Data Type*	Data Source**	Surrogate Analyte
Manganese	MN	44	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Mercury	HG	1.41	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	Mercury (Inorganic)
Mercury (methyl)	HGM	0.032	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Nickel	NI	43.9	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Selenium	SE	0.2	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Silver	AG	19	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Thallium	TL	0.0071	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Titanium	TI	15.8	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_SNL value	
Uranium (total)	U(total)	6.1	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	Uranium
Vanadium	V	2.1	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Zinc	ZN	126	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Acenaphthene	83-32-9	70	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Aroclor-1254	11097-69-1	0.611	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Aroclor-1260	11096-82-5	13.8	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Benzo(a)anthracene	56-55-3	0.17	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Benzo(a)pyrene	50-32-8	1	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Benzo(b)fluoranthene	205-99-2	4	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Benzo(g,h,i)perylene	191-24-2	7.2	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Bis(2-ethylhexyl)phthalate	117-81-7	18.3	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	

Table 4b. cont.

Analyte	Analyte Code	TRV	Units	Data Type*	Data Source**	Surrogate Analyte
Chrysene	218-01-9	0.17	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
DDE[4,4'-]	72-55-9	10	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
DDT[4,4'-]	50-29-3	1.07	mg/kg/d	Chronic GMM NOAEL	ECORDBR2.0NOV03_LANL derived value based on reviewed primary data	
Dieldrin	60-57-1	0.015	mg/kg/d	Chronic CS NOAEL	ECORDBR2.0NOV03_EPA EcoSSL value	
Endrin	72-20-8	0.092	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	
Endrin Aldehyde	7421-93-4	0.092	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_ORNL value	Endrin
Fluoranthene	206-44-0	12.5	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_SNL value	
Fluorene	86-73-7	125	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Naphthalene	91-20-3	0.5	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Phenanthrene	85-01-8	5.14	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_LANL value based on secondary data	
Pyrene	129-00-0	7.5	mg/kg/d	Chronic NOAEL	ECORDBR2.0NOV03_SNL value	

*CS stands for Critical Study. GMM stands for Geometric Mean. NOAEL stands for No Observed Adverse Effect Level.
** ECORDBR2.0NOV03 stands for Release 2.0 of the LANL RRES RS Project Ecorisk Database (LANL 2003). LANL stands for Los Alamos National Laboratory. ORNL stands for Oak Ridge National Laboratory. EPA EcoSSL stands for the U.S. Environmental Protection Agency Ecological Soil Screening Level Methodology. SNL stands for Sandia National Laboratories.

non-NOAELs to NOAELs, and 5) the selection of the most conservative and ecologically relevant chronic NOAEL to represent the CS TRV. Tier 4 TRVs are the least preferred values and are equal to TRVs reported by a secondary data source such as Oak Ridge National Laboratory (ORNL) or Sandia National Laboratories (SNL). They are the least preferred not because they are unacceptable values, but because the relevance of the value to LANL ecological risk assessments based on derivation methods is not as relevant as higher tiers or because the correctness of the data reported cannot be verified. There are exceptions to this hierarchy on a case-by-case basis. An example in this data set is the TRV for DDE [4,4'-] for birds, which is a Tier 2 TRV labeled as a subset GMM TRV. In this case the subset GMM TRV represents a GMM TRV calculated on a subset of the data available because it was found that some data were unsuitable and had to be excluded in order to protect against reproductive and developmental effects. Also note that in few cases the TRV for a surrogate analyte is used such as the case of Endrin Aldehyde where the TRV for Endrin is used as a surrogate TRV. Full documentation of the derivation of each TRV can be found in the Ecorisk Database (LANL 2003).

Documentation for Radionuclide TRVs. Table 5 (a, b, c) characterizes the radionuclide TRVs for the Western bluebird, Mexican spotted owl, and deer mouse, respectively. The table reports the TRV, data type, and data source. The TRVs for radionuclides are ESLs. ESLs for the deer mouse are available in the Database so these ESLs are taken directly from the Database and used as TRVs. Further information on the derivation of the deer mouse radioncuclide ESLs can be found in the Ecorisk Database R2.0 (LANL 2003). ESLs were not available directly from the Database for the owl and the bluebird, but models have been developed for their feeding guilds. The ESL for the owl is based on the American kestrel (*Falco sparverius*) model (carnivore/invertivore) and the ESL for the bluebird is based on the American robin (omnivore) model. Further information on these models can be found in a screening level ecological risk assessment methods document (LANL 1999). Receptor-specific information such as life span, body weight, food intake, and dietary component fractions and associated BCFs were used to calculate bluebird and owl radionuclide ESLs. See Table 5d for the parameters used. Parameters are also shown for the deer mouse since some of the listed parameters were also used by ECORSK.7 in the exposure calculation. Some site-specific data were derived and used. As the default, ECORSK.7 can calculate many of the parameters from various allometric equations when site-specific data are not available. Because the HR for the deer mouse is less than one grid in areal extent and data are only resolved to grid cell scale, the modeled exposure for the deer mouse is based on COPECs within a single grid cell. A receptor with such a small HR allows us to more easily track high HIs to contaminant source.

List of COPECs without TRVs. Sensitivity analyses performed in the 1990s using ECORSK.4 (Gallegos et al. 1997a) showed that of the many parameters used by the model, variation of the TRV and BCF parameters have the greatest effect on HIs and HQs. While uncertainty exists in the state of the art of toxic effects of contaminants on nonhuman biota, the LANL/RRES-RS method of TRV identification and derivation has resulted in only a few COPECs without TRVs. Table 6 lists the COPECs without TRVs for bird receptors. These COPECs were not included in the ECORSK.7 input files (eeuinp.dat) for the bird receptors. There were no COPECs without TRVs for the mammal receptor, so all COPECs were included in the eeuinp.dat file for the mammal receptor.

Table 5a. Radionclude TRVs for the Western Bluebird

Analyte	Analyte Code	TRV	Units	Data Type	Data Source*	Surrogate Analyte
Americium-241	AM-241	2.50E+04	pCi/g soil	ESL	ECORDB_RadESLModel	
Cesium-137	CS-137	4.70E+03	pCi/g soil	ESL	ECORDB_RadESLModel	Cs-137/ Ba-137
Plutonium-239, 240	PU-239/240	2.00E+04	pCi/g soil	ESL	ECORDB_RadESLModel	
Thorium-232	TH-232	2.70E+03	pCi/g soil	ESL	ECORDB_RadESLModel	

* ECORDB_RadESLModel indicates that the TRVs are calculated based on the radionuclide ESL models used by the LANL RRES RS Project Ecorisk Database.

Table 5b. Radionclude TRVs for the Mexican Spotted Owl

Analyte'	Analyte Code	TRV	Units	Data Type	Data Source*	Surrogate Analyte
Americium-241	AM-241	4.50E+04	pCi/g	ESL	ECORDB_RadESLModel	
Cesium-137	CS-137	3.60E+03	pCi/g	ESL	ECORDB_RadESLModel	Cs-137/ Ba-137
Plutonium-239, 240	PU-239/240	5.10E+04	pCi/g	ESL	ECORDB_RadESLModel	
Thorium-232	TH-232	7.10E+03	pCi/g	ESL	ECORDB_RadESLModel	

* ECORDB_RadESLModel indicates that the TRVs are calculated based on the radionuclide ESL models used by the LANL RRES RS Project Ecorisk Database.

Table 5c. Radionclude TRVs for the Deer Mouse

Analyte	Analyte Code	TRV	Units	Data Type	Data Source*	Surrogate Analyte
Americium-241	AM-241	32314	pCi/g soil	ESL	ECORDBR2.0NOV03	
Cesium-137	CS-137	2416	pCi/g soil	ESL	ECORDBR2.0NOV03	Cesium-137/ Barium-137
Plutonium-239, 240	PU-239/240	151353	pCi/g soil	ESL	ECORDBR2.0NOV03	
Thorium-232	TH-232	29033	pCi/g soil	ESL	ECORDBR2.0NOV03	

* ECORDBR2.0NOV03 indicates that the TRVs are from the LANL RRES RS Project Ecorisk Database Release 2.0.

Table 5d. Receptor Model Parameters

Parameter	Receptor		
	Mouse	Owl	Bluebird
Life span (d)	365	7300	2555
Body weight (kg)	0.02	0.6	0.253
Food intake (kg dwt/d)	0.004	0.019	0.006
Fraction plant diet	0.5	0	0.1
Fraction invertebrate diet	0.5	0.12	0.9
Fraction of flesh in diet	0	0.88	0
Fraction of soil in diet	0.02	0.05	0.05
Home Range (km^2)	6.4E-04	4.1	4.3E-03
Exponential foraging function	N/A	$e^{-r/350}$	N/A

Table 6. COPECs Without a TRV for Bird Receptors

Analyte Group	Analyte	Analyte Code
Inorganic	Antimony	SB
Inorganic	Beryllium	BE
Inorganic	Thallium	TL
Inorganic	Titanium	TI
Organic	Acenaphthene	83-32-9
Organic	Benzo(a)anthracene	56-55-3
Organic	Benzo(a)pyrene	50-32-8
Organic	Benzo(b)fluoranthene	205-99-2
Organic	Benzo(g,h,i)perylene	191-24-2
Organic	Chrysene	218-01-9
Organic	Fluoranthene	206-44-0
Organic	Fluorene	86-73-7
Organic	Phenanthrene	85-01-8
Organic	Pyrene	129-00-0

Spatial Scale and GIS/ECORSK.7 Interface

The site EEU was mapped using a GIS and GIS software ARC/INFO and Arcview as previously described in Gonzales et al. (2002). The spatial extent of the site EEU was shown in Figure 1. A grid was developed that would encompass this spatial extent of the EEU needed for the modeling activity. In ARC/INFO, a grid was created using the command GENERATE with the fishnet and labels option. The grid cell size was set to 30 × 30 m. The study area was comprised of about 31,885 grid cells. ECORSK.7 requires that each row and column of the site EEU grid be designated by a label. In addition, the coordinates of the center of each cell were needed. To accomplish this a *BASIC* program was used. These attributes were then added to the grid spatial data set.

Sensitivity Analysis

Eight different model execution scenarios were identified for the deer mouse to test the sensitivity of the model to different data sets or background value manipulations. The eight scenarios are defined in Table 7.

Scenario 1a uses some GMM TRVs and, where there were not sufficient data to compute GMM TRVs, CS TRVs were used. Scenario 1b uses CS TRVs. The TRVs used in Scenario 1b generally were lower so we would expect HIs to increase in Scenario 1b compared to Scenario 1a. While screening methodologies generally use conservative values such as CS TRVs, analyses methodologies such as Tier 2 or Tier 3 assessments generally use more realistic values such as means (USDOE 2000).

Various groups of background values used in the sensitivity analysis are shown in Table 8. Scenarios 1a and 1b both used a year-2000 background data set ("Eeuinp.dat background Database") that was used in ECORSK.6 as described in the report by Gonzales et al. (2002). The sources of background data for the Eeuinp.dat Database set (Scenarios 1a and 1b) were primarily soil values from a report by Fresquez et al. (1996) and soil horizon A values in a report by Longmire et al. (1996). The only difference between Scenarios 1b and 2a was that 2a used the RRES-RS Project background value data set ("RRES-RS Sediment Average") from McDonald et al. (2003) as shown in Table 8. Scenario 2b used the same set as in 2a plus some additional background values for several organic contaminants that were not used in Scenario 2a.

Table 7. Definitions of Sensitivity Analysis and Baseline Scenarios

Scenario ID	Contaminant Dataset	BCFs (TFs)*	TRVs	Background Data: Source	Background Data: Replace unsampled grid cells with background values?	Receptor
1a	FY01 Integrated w/ limited LAPCIR COPECs (n = 38)	R1.5 Ecorisk Database	2002 Eeuinp GMM TRVs CS TRVs used when no GMM TRV exists)	Gonzales et al. (2000)	Yes	deer mouse
1b	FY01 Integrated w/ limited LAPCIR COPECs (n = 38)	R1.5 Ecorisk Database	R1.5 Ecorisk Database CS TRVs	Gonzales et al. (2000)	Yes	deer mouse
2a	FY01 Integrated w/ limited LAPCIR COPECs (n = 38)	R1.5 Ecorisk Database	R1.5 Ecorisk Database CS TRVs	RRES-RS Sediment Average; Organic Values = 0. (Use soil data when no sediment data exists) ["y" or "yellow" values used]	Yes	deer mouse
2b	FY01 Integrated w/ limited LAPCIR COPECs (n = 38)	R1.5 Ecorisk Database	R1.5 Ecorisk Database CS TRVs	RRES-RS Sediment Average; Values for Organics (Use soil data when no sediment data exists) ["y" or "yellow" and "g" or "green" values used]	Yes	deer mouse
2c	FY01 Integrated w/ limited LAPCIR COPECs (n = 38)	R1.5 Ecorisk Database	R1.5 Ecorisk Database CS TRVs	RRES-RS Sediment Average; Organic Values = 0 (Use soil data when no sediment data exists) ["y" or "yellow" values]	No	deer mouse
3a**	FY03 ER Integrated w/ limited LAPCIR COPECs (n = 45) including DL replacement values	R1.5 Ecorisk Database	R2.0 Ecorisk Database TRVs	RRES-RS Sediment Average (Use soil data when no sediment data exists) ["y" or "yellow" values]	Yes	deer mouse, owl, and bluebird
3b	FY03 ER Integrated w/ limited LAPCIR COPECs (n = 45) including DL replacement values	R1.5 Ecorisk Database	R1.5 Ecorisk Database TRVs	RRES-RS Sediment Average (Use soil data when no sediment data exists) ["y" or "yellow" values]	Yes	deer mouse, owl, and bluebird
3c***	FY03 ER Integrated w/ limited LAPCIR COPECs (n = 45); sample value of '0' for non-detect results on naphthalene	R1.5 Ecorisk Database	R2.0 Ecorisk Database TRVs	RRES-RS Sediment Average (Use soil data when no sediment data exists) ["y" or "yellow" values]	Yes	deer mouse, owl, and bluebird

* TFs = transfer factors
** LAPCIR Preliminary Baseline
*** LAPCIR Adjusted Baseline

Table 8. Background Values for COPECs Used in ECORSK.7

Group	Analyte name	Analyte code*	Surrogate	ER soil average**	ER soil BV**	ER sed average**	ER sed BV**	Eeuinp.dat***
inorg	Antimony	SB	**Antimony**	0.505[y]	0.83			0.5
inorg	Arsenic	AS	**Arsenic**	3.95	8.17	1.84[y]	3.98	6.99
inorg	Barium	BA	**Barium**	143	295	60.4[y]	127	263
inorg	Cadmium	CD	**Cadmium**	0.364	0.4	0.093[y]	0.4	1.4
inorg	Chromium (total)	CR	**Chromium (total)**	9.04	19.3	5.62[y]	10.5	19.3
inorg	Cobalt	CO	**Cobalt**	5.16	8.64	2.35[y]	4.73	31
inorg	Copper	CU	**Copper**	6.06	14.7	4.57[y]	11.2	30.7
inorg	Cyanide (total)	CN(-1)	**Cyanide (total)**			0.295[y]	0.82	0
inorg	Lead	PB	**Lead**	12.7	22.3	9.25[y]	19.7	28.4
inorg	Manganese	MN	**Manganese**	340	671	290[y]	543	1000
inorg	Mercury (inorganic)	HG	**Mercury (inorganic)**	0.053	0.1	0.012[y]	0.1	0.09
inorg	Mercury (methyl)	HGM	**Mercury (methyl)**			0.000024[g]	0.0002	--
inorg	Nickel	NI	**Nickel**	7.07	15.4	4.98[y]	9.38	12.2
inorg	Selenium	SE	**Selenium**	0.447	1.52	0.1[y]	0.3	0.7
inorg	Silver	AG	**Silver**			0.066[y]	1	0
inorg	Thallium	TL	**Thallium**	0.276[y]	0.73			0.4
inorg	Titanium	TI	**Titanium**			242[y]	439	0
inorg	Uranium	U(total)	**Uranium or U**	3.8	5.4	3.76[y]	6.99	0
inorg	Zinc	ZN	**Zinc**	31.5	48.8	33.9[y]	60.2	47.1
pah	Acenaphthene	83-32-9	**Acenaphthene**			0	0	0
pah	Benzo(a)anthracene	56-55-3	**Benzo(a)anthracene**			0.0079[g]	0.11	0
pah	Benzo(a)pyrene	50-32-8	**Benzo(a)pyrene**			0.0086[g]	0.12	0
pah	Chrysene	218-01-9	**Chrysene**			0.0093[g]	0.13	0
pah	Fluorene	86-73-7	**Fluorene**			0	0	0
pah	Naphthalene	91-20-3	**Naphthalene**			0	0	0
pah	Phenanthrene	85-01-8	**Phenanthrene**			0.02[g]	0.16	0
pah	Pyrene	129-00-0	**Pyrene**			0.014[g]	0.2	0

Table 8. cont.

Group	Analyte name	Analyte code[*]	Surrogate	ER soil average[**]	ER soil BV[**]	ER sed average[**]	ER sed BV[**]	Eeuinp.dat[***]
pcb	Aroclor-1254	11097-69-1	**Aroclor-1254**			0.0011[g]	0.015	0
pcb	Aroclor-1260	11096-82-5	**Aroclor-1260**			0.029[g]	0.087	0
pest	DDE[4,4'-]	72-55-9	**DDE[4,4'-]**			0.0063[g]	0.023	0.026
pest	DDT[4,4'-]	50-29-3	**DDT[4,4'-]**			0.016[g]	0.061	0.104
pest	Dieldrin	60-57-1	**Dieldrin**			0.00038[g]	0.0026	0
pest	Endrin Aldehyde	7421-93-4	**Endrin**			0	0	0
rad	Americium-241	AM-241	**Americium-241**	0.0064	0.013	0.026[y]	0.04	0.04
rad	Cesium-137	CS-137	**Cesium-137/Barium-137**	0.42	1.65	0.211[y]	0.9	0.43
rad	Plutonium-239, 240	PU-239/240	**Plutonium-239, 240**	0.015	0.054	0.025[y]	0.068	0
svoc	Bis(2-ethylhexyl)phthalate	117-81-7	**Bis(2-ethylhexyl)phthalate**			0.069[g]	0.34	0
COPECs Added								
inorg	Beryllium	BE	**Beryllium**			0.59[y]	1.31	
inorg	Boron	B	**Boron**			1.4[y]	4.1	
inorg	Vanadium	V	**Vanadium**			10.4[y]	19.7	
pah	Benzo_b_fluoranthene	205-99-2	**Benzo_b_fluoranthene**			0.0066[g]	0.093	
pah	Benzo_g_h_i_perylene	191-24-2	**Benzo_g_h_i_perylene**			0.01[g]	0.14	
pah	Fluoranthene	206-44-0	**Fluoranthene**			0.046[g]	0.22	
pest	Endrin	72-20-8	**Endrin**			0	0	
rad	Thorium_232	TH-232	**Thorium_232**			1.43[y]	2.33	
COPECs Deleted								
inorg	Uranium	U	**Uranium**	0.985	1.82	0.685[y]	2.22	1.87

* Analyte code: Added in the column and data from TbAnCd of Ecorisk Database R1.5 to guide in search of values in eeuinp.dat database tables.
** Averages and BV [background values] are from the LANL ER summary document, except for organics from reach LA-0.
*** Euinp.dat Database background values are from a file titled “DeerMouseEeuinpDb_092302.mdb” that were used in a report by Gonzales et al. (2002).
y Indicates a value that was used in the background data set of particular scenarios identified in Table 7.
g indicates a value that was used in the background data set of particular scenarios identified in Table 7.

Background values for organics were based on the average detected sample results from LAPCIR reaches at the head of Los Alamos (reach LA-0) and Pueblo (reach P-1FW) Canyons. These LAPCIR reaches are located upstream of any known LANL PRSs. For Scenarios 1a through 2b when a grid cell was encountered that had not been sampled, thus having no contaminant data, ECORSK.7 entered background values, thus background was included for every grid cell in the EEU. This can be problematic in that when TRVs are overly conservative (unrealistically low), such as CS TRVs might be, large HIs/HQs (in excess of 1.0) can result, with the predominant contribution of potential effect coming from background levels of COPECs rather than Lab-added COPECs. Therefore, an option in ECORSK.7 (not available in previous versions) is to ignore grid cells where sampling has not been conducted; i.e., include background values only in grid cells where sample values exist. Scenario 2c differs from 2a in that 2c includes background values only in grid cells where sample values exist. This would not make a difference when Adjusted Risk (Total-Background) is computed but it would for Unadjusted (Total) Risk and Background Risk.

Scenario 3—Baseline Scenario

Scenario 3, the baseline risk scenario, represents the most current data used in ECORSK.7. It incorporates the final LAPCIR data for a limited set of 45 COPECs, uses current food-chain transfer factors and some GMM TRVs from the R2.0 Ecorisk Database (LANL 2003), uses the RRES-RS "sediment average" background data set, and has background values included in every grid cell. The sediment/contaminant data set includes some values, mostly in Pueblo Canyon, that might have been affected by runoff resulting from the Cerro Grande Fire but includes no data directly relating to fire-generated media, such as from ash or "muck" samples.

RESULTS

Sensitivity Analysis

A sensitivity analysis was conducted using the deer mouse as the receptor to test the effects of different data sets or background value manipulations on HI results. Table 9 is a summary of the results. Pairs of scenarios were contrasted and for each pair of scenarios a summary of the parameter change that was tested is included. In all four cases HIs changed in the direction expected and the amount of change that occurred is quantified by indicating the change in unadjusted mean total HI as a percentile.

The largest changes in HIs were associated with TRV selection and background data selection. The use of Ecorisk Database R1.5 TRVs (mostly CS TRVs) increased the mean total HI by about 260% in comparison to R2.0 TRVs (mostly GMM TRVs). As discussed in the Methods section, CS TRVs are typically lower than GMM TRVs and sometimes the value used as a CS TRV is the lowest TRV available in the literature. Since GMM TRVs are a central tendency value based on several values they are typically higher. We consider GMM TRVs the most appropriate because there are still conservatisms built into the derivation that lead to protection of the receptors.

Two background data sets were contrasted in the comparison of Scenario 1b with 2a. The two background value data sets that were contrasted were "2000 Eeuinp" and "RRES-RS Sediment Averages," which excluded organics. The "2000 Eeuinp" set used single soil values with two sources—Fresquez et al. (1996) and Soil Horizon A values from a report by Longmire et al. (1996). This set also used regional background values for DDE and DDT (Gonzales and Podolsky 2000). The "RRES-RS Sediment Averages" set is from McDonald et al. (2003). Use of the RRES-RS set decreased the unadjusted mean total HI by 76%.

Table 9. Subjective Evaluation of Sensitivity Analysis Data for Deer Mouse. Values in third column are unadjusted ("UNADJ") mean total HIs for paired scenarios. For Scenarios 1a-2b, we selected the option to replace "empty" grids that are within the EEU with background values.

Scenarios Compared	Parameter Change	Expected Delta	Subjective Evaluation of Actual Delta*
1a – 1b	GMM TRVs → CS TRVs	TRVs decrease, so UNADJ HI should increase.	√+ Increased 260%.
1b – 2a	2000 eeuinp bckg→RRES-RS bckg	ER bckg values are lower, and bckg is the numerator in the HI calc, so UNADJ HI should decrease.	√+ Decreased by 76%. A decrease was expected and the decrease was by a large amount. Scenario 2a bckg values are quite a bit lower (see background values comparison table.xls).
2a – 2b	RRES-RS bckg (no organics)→RRES-RS bckg w/organics	More bckg values (numerator) in 2b, but they are very low and TRV for mammals is often one order higher, so not much change (if any) in UNADJ HI is expected. If anything, a very slight increase.	√ No change, as expected.
2a – 2c	Bckg values handled the "new" way where a bckg value is included in every grid cell→Handled "old" way where bckg entered only in cells where a "hit" occurred.	2c uses the same exact data as 2a, but in 2c backgrounds are handled as was coded in ECORSK.6 and lower versions whereby background IS NOT included for every cell. If in 2a bckg values are entered in every grid cell, then the HI should be higher for 2a than 2c where an HI for every cell is summed.	√+ Decreased by 32%. Decreased when a decrease was expected and the amount of change seems appropriate (subjective).

* √+ = Actual change in mean total HI was in the direction expected and the amount of change seems reasonable when subjectively evaluated.
√ = Basically the expected results occurred.

Comparison of Scenarios 2a and 2b showed that the inclusion of above-zero organic background values (in comparison to using the theoretical background of '0') had no impact on HIs for the deer mouse. This observation is consistent with organic chemicals not being potential risk drivers for the deer mouse.

Comparison of Scenarios 2b and 2c involved the issue of how background values for grid cells that have no data (have not been sampled) are handled. This comparison is necessary so that results from ECORSK.7 can be compared to previous model results where grid cells with no sample data were ignored. Not assuming a background value for unsampled grid cells, but rather ignoring exposure from those cells, resulted in a 32% decrease in the unadjusted mean total HI.

Comparison of 3a and 3b investigated the effect of R2.0 Database vs. R1.5 Database TRVs in all three receptors. This comparison is similar to 1a vs 1b, but uses current data and the comparison was for all three receptors. The results are discussed in the next section.

The last comparison (3a—Preliminary Baseline and 3c—Adjusted Baseline) involved the issue of what to do in grid cells where an analytical result of "non-detect" occurred for one or more COPECs. As mentioned, for the Scenario 3a data set, DL values were substituted for some non-detect results in order to be consistent with how non-detects had been previously handled for the SWEIS database. The SWEIS data set was constructed in 1999 and continues to be the data set that represents non-canyon areas in ECORSK modeling. Under Scenario 3a naphthalene was a dominant contributor to HIs for the owl and bluebird. In the area of the Los Alamos town site naphthalene analysis had been requested as part of a suite of many organics analyzed following the Cerro Grande Fire. Consequently, DLs were used in place of many non-detects that resulted in certain areas, especially DP and Acid Canyons, which are small side canyons to Los Alamos and Pueblo Canyons below the town site. Consequently relatively high values were entered for naphthalene in those areas. An analysis of the data show a strong argument that there most likely is no naphthalene present in soils and sediment at LANL. Naphthalene is relatively volatile under ambient environment conditions, especially in the summer when temperatures would volatilize most naphthalene. The only known sources of naphthalene were combustion of organics in the town site upstream of DP and Acid Canyons. Subsequent to the original post-fire sampling, additional sampling and analysis for naphthalene with DLs close to zero yielded results of non-detects. The results of Scenario 3c modeling are discussed in the next section.

Baseline Scenarios

The baseline scenarios reflect the most current contaminant data and toxicological parameters and the most recent assumptions and decisions on parameter selections. Tables 10–14 have data for Scenarios 3a and 3c.

Preliminary Baseline Scenario (Scenario 3a). Using R2.0 TRVs (mostly GMM TRVs), the unadjusted mean HIs of 9.8 for the deer mouse and 6.3 for the bluebird were dominated by contributions from background sources. The unadjusted mean HI for the owl (0.945) was dominated by anthropogenic sources; however, it was within the safe limit of 1.0. HIs of less than 1.0 indicate that, on average, no effects are expected because exposure doses did not exceed protective safe limits.

The HI for each of the 100 owl nest sites is shown in Table 11 and the mean total HQs by COPEC across the 100 nest sites are in Table 12. Seventeen of the 100 nest sites had HIs over 1.0. Although HQs should be added only for COPECs that cause the same or similar effects, separation of the HQs for the radionuclides, as an example, would reduce the mean total HI by an insignificant amount.

Table 10. Mean Total HIs for Scenario 3a—Three Receptors Using Some Detection-Limit Replacement Values and Ecorisk Database R2.0 TRVs

Risk Source	Mean HI*	Maximum HI	COPECs With HQ>0.3
Deer Mouse			
Unadjusted	9.78**	45.5	Tl (4.2), Ti (1.6), As (1.1), Sb (1.1), V (0.5), Mn (0.4)
Background	9.45	36.7	Tl (4.1), Ti (1.6), As (1.1), Sb (1.0), V (0.5), Mn (0.4)
Adjusted	0.33		
Mexican Spotted Owl			
Unadjusted	0.945	8.9	Naphthalene (0.3)
Background	0.217	2.1	
Adjusted	0.728		
Western Bluebird			
Unadjusted	6.27	64.4	V (1.9), Cyanide (1.7), Zn (0.6), Pb (0.3), Naphthalene (0.7)
Background	5.09	6.8	V (1.9), Cyanide (1.6), Zn (0.6), Pb (0.3)
Adjusted	1.18		

*Value is an arithmetic mean of total observations/nest site HIs (1000 for deer mouse and bluebird; 100 for owl).
**Contains contribution from natural and anthropogenic sources.

Scenario 3b. Using the more conservative CS TRVs, unadjusted mean total HIs were higher—50.4, 29.7, and 2.95 for the deer mouse, bluebird, and owl, respectively—however, again a large percentage of the HI was contributed from background sources. As described in the Methods, CS TRVs are sometimes the only or the minimum of several values found in the literature applied to our particular receptors and this is yet another method of overestimating HIs so as to be protective. The use of CS TRVs resulted in some HQs for individual COPECs that were above 0.3 and that were contributed by anthropogenic sources. COPEC-specific HQs greater than 0.3 have been previously used at LANL as a threshold for further investigating possible COPECs. DDT, cobalt, and DDE had HQs of 0.9, 0.8, and 0.5, respectively. We believe that the majority of the DDT and its derivatives that are detected at LANL are primarily the result of a single massive spraying of high concentrations of DDT in 1963 of one-half a million acres west of the Rio Grande (Gonzales et al. 1999). Given the concentration that was sprayed and the breakdown rate of DDT in the environment, concentrations would still be detectable (Gonzales et al. 1999). The reason that antimony, thallium, and titanium dropped out as dominant contributors for the birds in comparison to the deer mouse was that we had no avian TRV for these COPECs. Naphthalene is a key contributor to potential avian risks and is the large contributor to the net HI (unadjusted HI minus background HI). Naphthalene is a key constituent in mothballs, and it is classified as a semivolatile but it is actually on the more volatile end of these compounds and would not be very persistent in the environment. Naphthalene is also one of the COPECs that have a range of DLs in the canyons data, and many of these DLs, which were used in place of "non-detects" are relatively elevated. So the conservatism resulting from the replacement was probably most pronounced for naphthalene.

Adjusted Baseline Scenario (Scenario 3c). This scenario was a repeat of Scenario 3a with an adjustment for how non-detects for naphthalene were handled for the bird receptors. We set the DL to zero for non-detects so that, in essence, a value of '0' was entered for non-detect results on naphthalene. Table 13 has the mean total HI results for Scenario 3c. The most notable changes compared with Scenario 3a were that the Adjusted HI for the owl decreased from 0.73

Table 11. Unadjusted HIs for 100 Randomly Selected Nest Sites for the Mexican Spotted Owl

Grid Cell ID							
Column	Row	HI	Nest No.	Column	Row	HI	Nest No.
197	477	8.93E+00	53	324	525	1.57E-01	21
254	478	8.65E+00	50	334	522	1.57E-01	52
239	477	8.43E+00	26	165	521	1.52E-01	59
129	489	7.68E+00	33	289	529	1.26E-01	91
189	490	7.25E+00	20	381	469	9.89E-02	51
268	478	6.56E+00	13	358	501	7.86E-02	94
271	465	5.93E+00	56	393	496	7.09E-02	97
166	496	3.75E+00	22	154	525	6.43E-02	83
138	490	3.51E+00	4	93	514	6.40E-02	44
267	462	3.42E+00	8	426	443	5.82E-02	3
136	481	3.10E+00	7	438	436	5.38E-02	25
294	478	2.96E+00	47	439	451	5.38E-02	88
169	499	2.62E+00	95	118	506	4.60E-02	55
284	482	1.71E+00	15	382	502	3.68E-02	80
307	476	1.54E+00	35	198	550	3.03E-02	85
323	468	1.23E+00	27	517	435	2.71E-02	16
232	520	1.13E+00	42	403	503	2.57E-02	46
240	504	8.84E-01	11	131	511	2.34E-02	28
318	455	8.31E-01	62	397	492	1.96E-02	40
365	471	8.03E-01	37	394	444	1.79E-02	45
309	454	7.08E-01	36	416	467	1.64E-02	99
240	528	7.00E-01	38	210	568	1.47E-02	48
337	460	6.26E-01	86	407	465	1.39E-02	61
359	474	6.14E-01	63	457	456	1.31E-02	32
247	510	5.75E-01	65	438	467	1.29E-02	96
344	474	5.53E-01	5	181	543	1.26E-02	39
254	528	5.41E-01	79	448	425	1.21E-02	43
51	494	5.34E-01	1	526	429	1.09E-02	87
213	529	4.83E-01	29	474	446	9.63E-03	70
199	526	4.74E-01	58	442	425	8.12E-03	93
331	478	4.28E-01	78	537	440	6.91E-03	10
220	533	4.12E-01	9	161	564	6.03E-03	17
190	514	4.05E-01	12	444	491	5.64E-03	71
72	493	3.83E-01	6	141	554	5.41E-03	24
270	506	3.82E-01	72	169	574	5.28E-03	54
263	528	3.80E-01	75	499	458	5.12E-03	73
360	480	3.74E-01	31	410	483	4.46E-03	90
309	495	3.52E-01	57	547	436	4.29E-03	30
333	484	3.40E-01	2	411	428	4.12E-03	77
354	493	3.35E-01	60	502	461	4.01E-03	18
306	503	3.21E-01	64	193	560	4.00E-03	82
327	510	3.06E-01	14	536	466	3.65E-03	98
326	522	2.81E-01	89	518	463	3.60E-03	68
349	498	2.40E-01	19	437	423	3.21E-03	81
352	501	2.28E-01	84	491	466	2.76E-03	23
87	496	2.25E-01	100	168	552	2.74E-03	67
300	523	2.21E-01	66	519	468	2.53E-03	41
87	497	2.17E-01	49	532	472	1.99E-03	34
188	519	2.16E-01	76	530	473	1.98E-03	92
185	522	2.08E-01	69	526	474	1.67E-03	74

Table 12. Ranked Unadjusted Mean Total HQ by COPEC for the Mexican Spotted Owl

Analyte	ID	Mean HQ	No. Obsv.	Mean Soil Conc. (mg/kgdwt or pCi/kgdwt)	Mean COPEC Intake (mg/kg/d or pCi/kg/d)
Naphthalene	20	2.89E-01	100	3.56E-01	7.49E-11
Cyanide	10	2.00E-01	100	6.32E-01	2.06E-10
Aroclor-1254	7	9.54E-02	100	6.39E-02	8.37E-12
Bis(2-ethylhexyl) phthalate	16	6.90E-02	100	4.02E-01	8.31E-11
Vanadium	12	4.66E-02	100	9.44E+00	4.10E-08
DDE[4,4’]	21	4.05E-02	100	1.17E-02	1.41E-13
Lead	4	3.70E-02	100	2.61E+01	4.59E-07
DDT[4,4’]	22	2.61E-02	100	2.56E-02	1.20E-12
Zinc	6	2.54E-02	100	4.62E+01	1.36E-06
Endrin	24	2.29E-02	100	8.69E-03	4.82E-14
Endrin	25	2.16E-02	100	8.17E-03	4.23E-14
Mercury	30	1.43E-02	100	2.13E-04	2.76E-17
Mercury	11	1.19E-02	100	6.17E-02	5.46E-12
Aroclor-1260	8	8.18E-03	100	1.12E-01	1.11E-11
Copper	3	7.98E-03	100	9.43E+00	4.75E-08
Selenium	19	6.48E-03	100	5.04E-01	1.33E-10
Barium	1	5.12E-03	100	6.99E+01	2.40E-06
Dieldrin	23	3.66E-03	100	8.77E-03	4.89E-14
Cadmium	13	3.03E-03	100	2.21E-01	2.63E-11
Boron	28	2.78E-03	100	1.50E+00	1.02E-09
Cobalt	14	2.00E-03	100	2.64E+00	3.13E-09
Manganese	5	1.49E-03	100	3.10E+02	4.43E-05
Arsenic	9	1.42E-03	100	1.78E+00	1.47E-09
Silver	17	5.74E-04	100	5.74E-01	2.68E-10
Chromium	29	4.39E-04	100	6.42E+00	1.89E-08
Nickel	15	4.03E-04	100	4.29E+00	8.36E-09
Thorium-232	26	3.64E-04	100	1.68E+00	1.30E-09
Uranium	31	2.92E-04	100	4.23E+00	8.23E-09
Cesium-137	2	1.07E-04	100	9.50E-01	1.74E-09
Plutonium-239	18	4.58E-05	100	1.59E+00	7.74E-09
Americium-241	27	2.15E-06	100	1.77E-01	1.80E-10

to 0.45, the Adjusted HI for the bluebird dropped to less than 1.0 (0.54), and naphthalene was eliminated as a dominant (HQ>0.3) contributor for the two birds. Table 14 has frequency distributions of mean total HIs. There are two situations that can result in HIs equal to zero, mostly associated with adjusted values. Grid cells that have not been sampled nor have interpolated data are assumed to have no Lab-added risk or can be interpreted as the animal receiving no “known” LANL-specific COPEC dose. Grid cells that have been sampled but where the sample value was less than background could also be interpreted as having no Lab-added

Table 13. Mean Total HIs for Three Receptors Using Ecorisk Database R2.0 TRVs and a DL Equal to Zero for Non-Detect Naphthalene Results

Risk Source	Mean Total HI*	Maximum HI	COPECs With HQ>0.3
Deer Mouse			
Unadjusted	9.78	45.5	Tl (4.2), Ti (1.6), As (1.1), Sb (1.1), V (0.5), Mn(0.4)
Background	9.45	36.7	Tl (4.1), Ti (1.6), As (1.1), Sb (1.0), V (0.5), Mn (0.4)
Adjusted	0.33	15.4	
Mexican Spotted Owl			
Unadjusted	0.666	6.5	None >0.3
Background	0.217	0.56	None >0.3
Adjusted	0.449	4.4	None >0.3
Western Bluebird			
Unadjusted	5.63	55.8	V (1.9), Cyanide (1.7), Zn (0.6), Pb (0.3)
Background	5.09	6.8	V (1.9), Cyanide (1.6), Zn (0.6), Pb (0.3)
Adjusted	0.54	48.9	

* Value is an arithmetic mean of total observations/nest site HIs (1000 for deer mouse and bluebird; 100 for owl).

Table 14. HI Frequency Distribution for Scenario 3c—Adjusted Baseline

Unadjusted					
HI Range	**Deer Mouse**	**HI Range**		**Owl**	**Bluebird**
>10.0	413	**>3.0**		7/100	800/1000
1.0-10.0	686	**1.0-3.0**		9/100	183/1000
<1.0	0	**<1.0**		84/100	17/1000
Background					
HI Range	**Deer Mouse**	**HI Range**		**Owl**	**Bluebird**
>10.0	309	**>3.0**		0/100	787/1000
1.0-10.0	691	**1.0-3.0**		7/100	196/1000
<1.0	0	**<1.0**		93/100	17/1000
Adjusted					
HI Range	**Deer Mouse**	**HI Range**	**Deer Mouse**	**Owl**	**Bluebird**
>10.0	4/1000	**>3.0**	46/1000	4/100	65/1000
1.0-10.0	54/1000	**1.0-3.0**	12/1000	9/100	41/1000
>0<1.0	9/1000	**>0<1.0**	9/1000	76/100	33/1000
=0	933/1000	**=0**	933/1000	11/100	861/1000

risk. A large percentage of Adjusted HI results are zeros for animals with small HRs. Eighty-six percent of the Adjusted HIs were zero for the bluebird, 93% were zeros for the deer mouse, and the owl had only 11% of its 100 HIs equal to zero. The larger HR for the owl results in its encounter of at least one grid cell that has a sampling result and contributes to a non-zero HI. These percentages of nest sites with HI = 0 somewhat overestimate the proportion of animals that encounter no LANL-derived COPEC sources within their HR. More important is an examination of the relatively high HI results.

Risk by Geographical Area. Contours of HIs are useful for demarcating general areas of risk. Figures 3–5 show the physical distribution of HIs in the study area for each of the receptors and corresponding box plots by geographically relevant areas. Being that the modeled animal exposures are a result of a number of interactions, including weighted animal distributions, spatial distributions of contaminants, toxicological and biological functions, and, in the case of the owl, distance-based exponential foraging, HIs and HI contours are complex and not necessarily directly proportionate with contaminant level distributions. Although the deer mouse and bluebird have a large proportion of the study area covered by unadjusted HIs greater than 1.0 and reach maximums in the 10's, on average over 90% of the risk was contributed by background sources. For the owl the highest HIs were concentrated in the area of upper to middle Los Alamos Canyon. Los Alamos Canyon extends into the Jemez Mountains west of LANL and could receive diffuse sources of DDTs over long periods of time. Effects of the Cerro Grande Fire of 2000 on contaminant release and transport are somewhat reflected in data used in ECORSK.7 as the canyons data contain some post-fire samples. Concentrations of cobalt greater than background can be measured in post-fire deposits and cobalt is also greater than background in Acid Canyon, which is a non-fire-impacted area. However, the most important information about cobalt is that the CS TRV (Ecorisk Database R1.5) was based on secondary studies with limited information and had an uncertainty factor of 100 applied to derive the TRV, whereas the Ecorisk Database R2.0 TRV is from the EPA Eco-SSLs and has much greater confidence. Thus, risks associated with cobalt are better defined by the baseline scenario results, which is to mean that cobalt risks are negligible. The key contributors to risk for the owl nest sites in upper Los Alamos Canyon were Aroclor-1254 and naphthalene. As discussed above naphthalene has many non-detected sample results and some of the sample-specific DLs, used in place of the non-detects, are elevated. The HQ for the naphthalene is primarily from elevated DLs in upper Los Alamos and DP Canyons (or the hypothetical foraging range of owls in this part of Los Alamos Canyon). Thus, the elevated naphthalene HQ is an artifact of elevated DLs for this COPEC. Higher Aroclor-1254 sample results were reported in parts of upper Los Alamos Canyon, and thus some greater modeled risk from PCBs to owls is reasonable.

In 1997, ECORSK.4 was executed on the Mexican spotted owl and, for the area that included Los Alamos Canyon, results were similar. Box plots of this year's HIs in Figures 3-1a and 3-1c show that many of the high HIs are in non-canyons (mesa tops), most likely where contaminated sites (PRSs) exist.

Examination of the adjusted risk can be useful because, although it does not convey the total risk to an animal, it can identify areas of Lab-added risk that can serve as the focus of uncertainty analysis, empirical studies, or other additional analyses. Table 15 has adjusted mean HIs for selected nest sites (deer mouse and bluebird: HIs>3.0; owl: HIs>1.0) for the three receptors. The mean HI for the selected nest sites was 6.8, 2.2, and 6.7 for the deer mouse, owl, and bluebird, respectively. The locations of these relatively high HIs for the selected nest sites correspond well with the contour intervals in Figures 3–5 regardless of how naphthalene non-detects were handled.

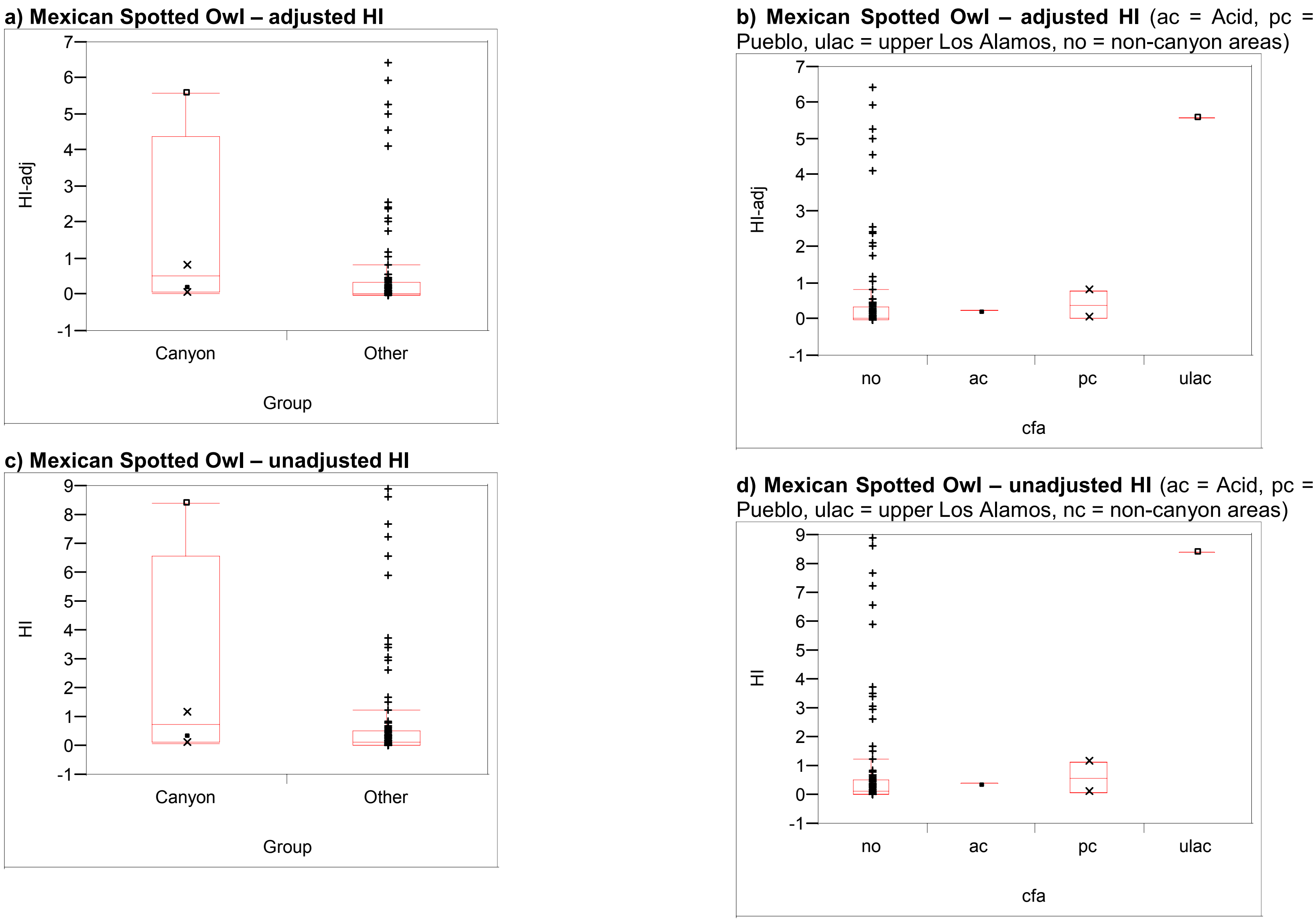


Figure 3-1. **Box plots showing distribution of adjusted (a and b) and unadjusted (c and d) HIs grouped by geographical areas for the Mexican spotted owl.**

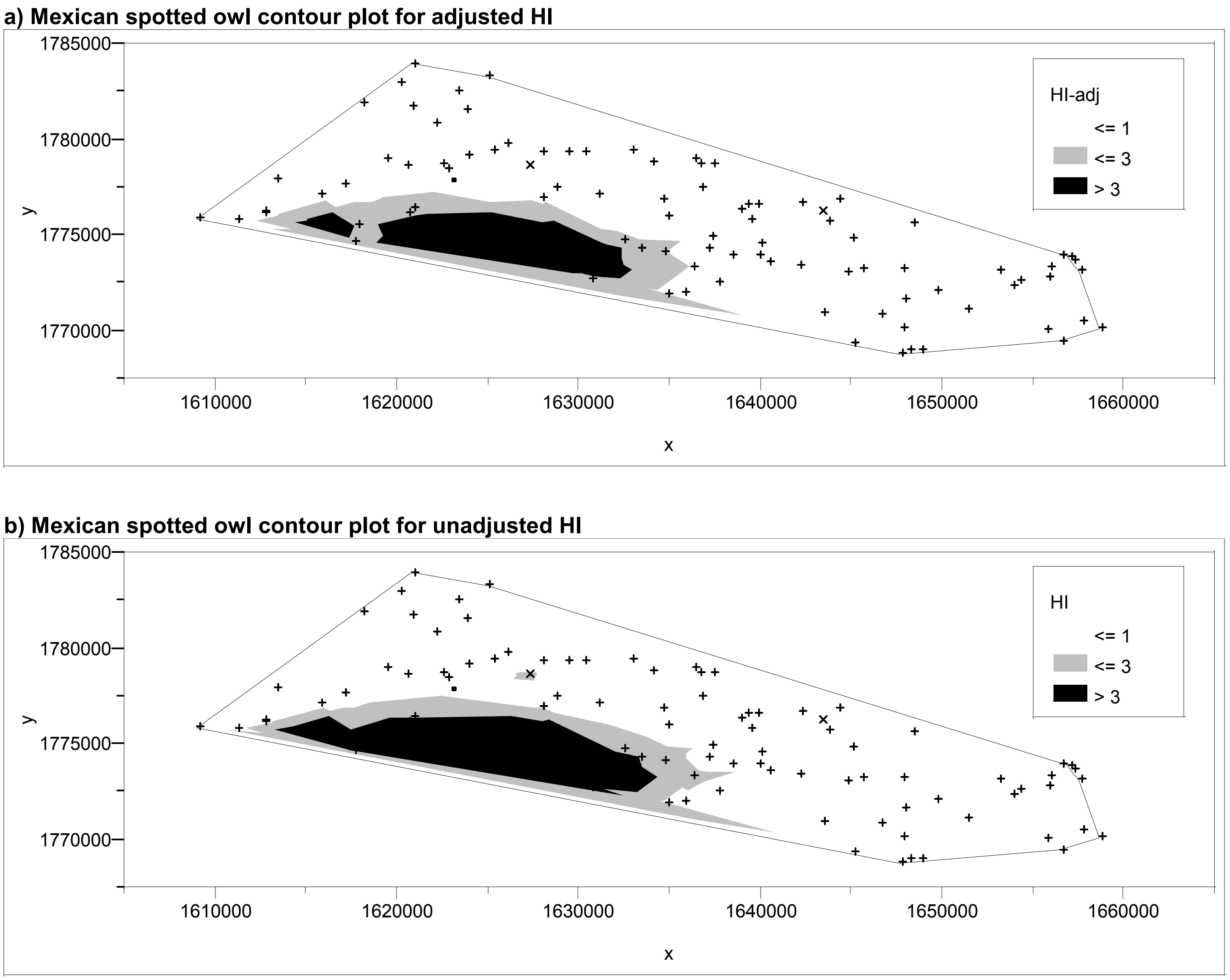


Figure 3-2. Contour plots of adjusted (a) and unadjusted (b) HIs for the Mexican spotted owl.

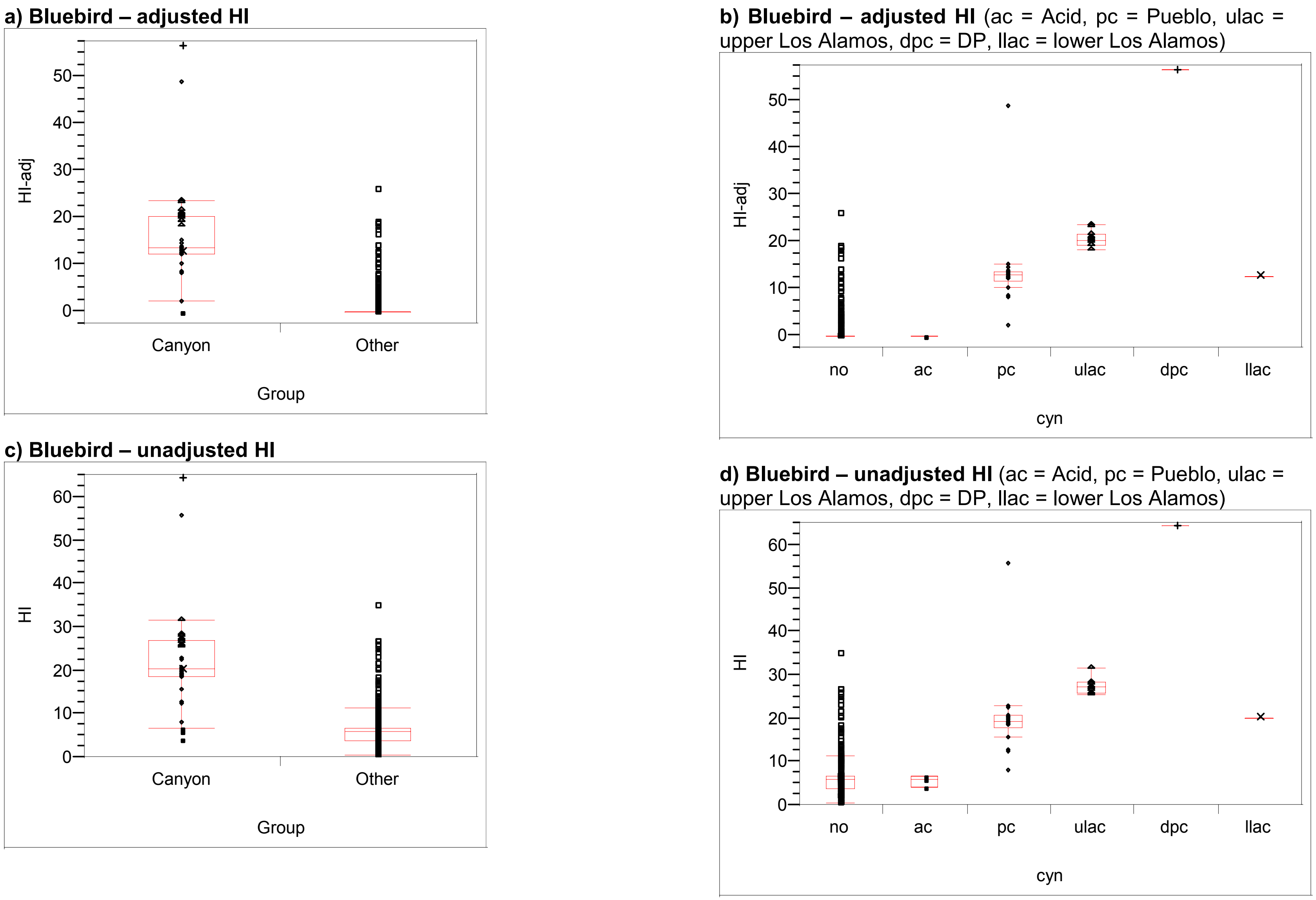
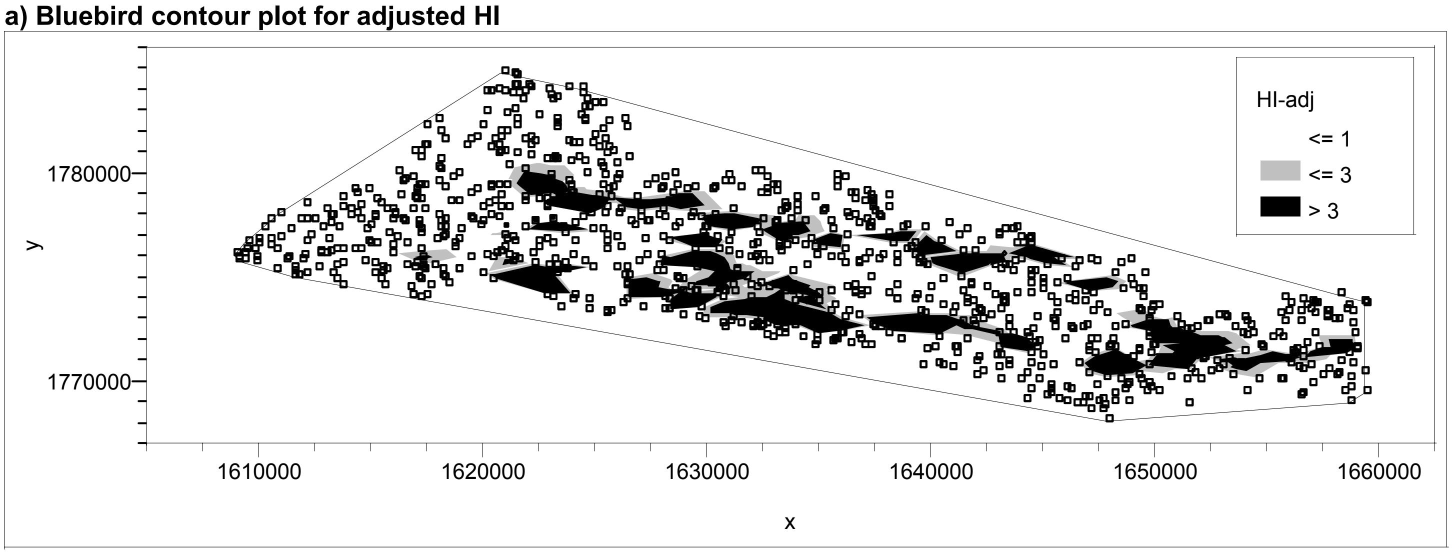


Figure 4-1. **Box plots showing distribution of adjusted (a and b) and unadjusted (c and d) HIs grouped by geographical areas for the Western bluebird.**



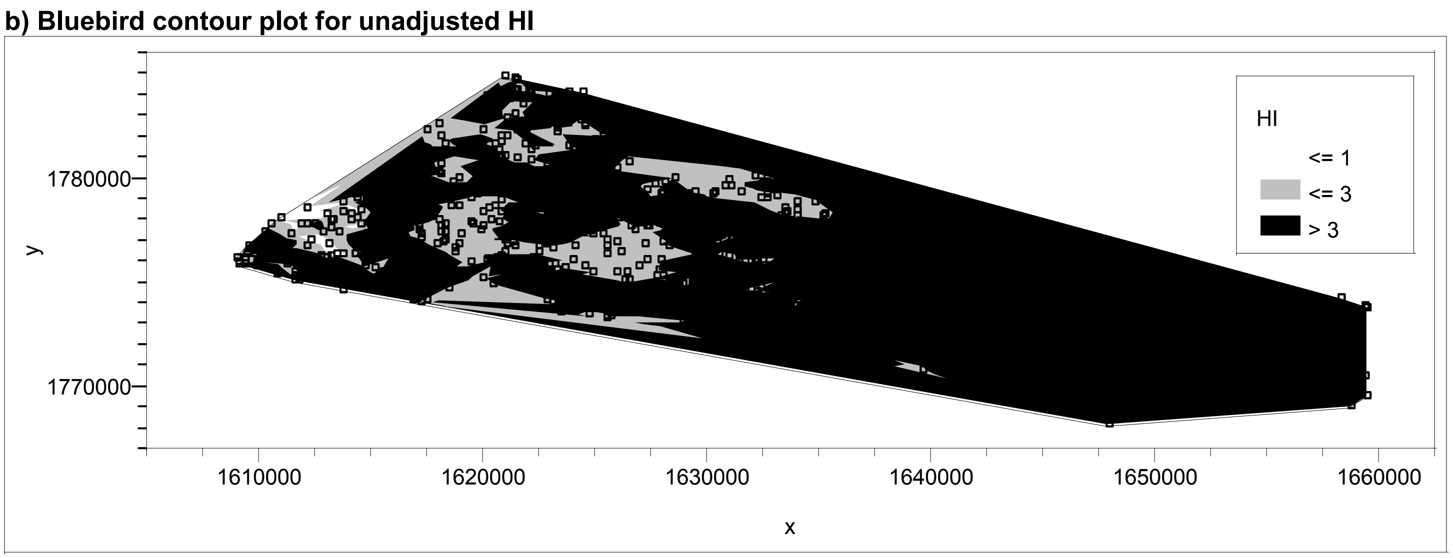


Figure 4-2. Contour plots of adjusted (a) and unadjusted (b) HIs for the Western bluebird.

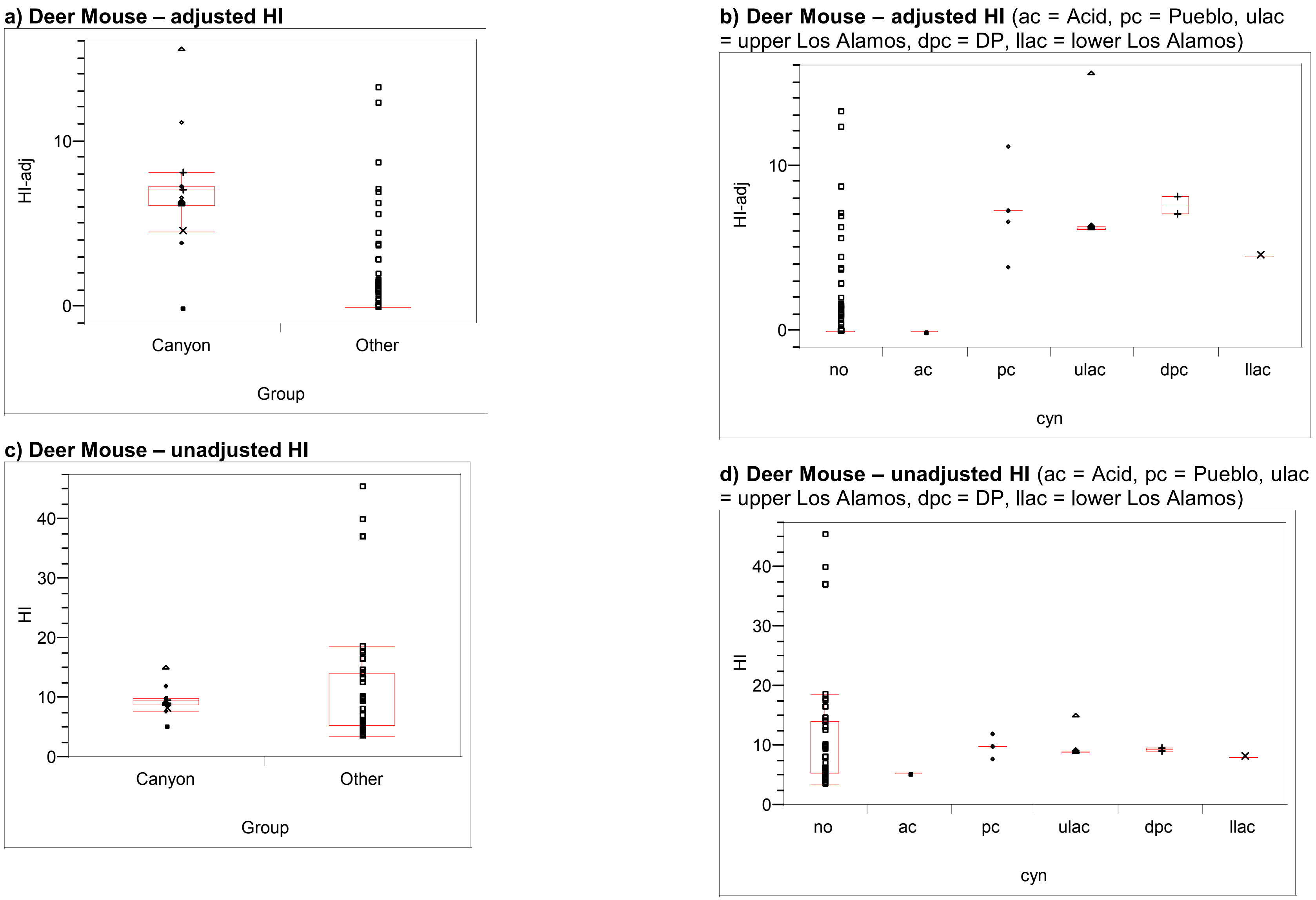
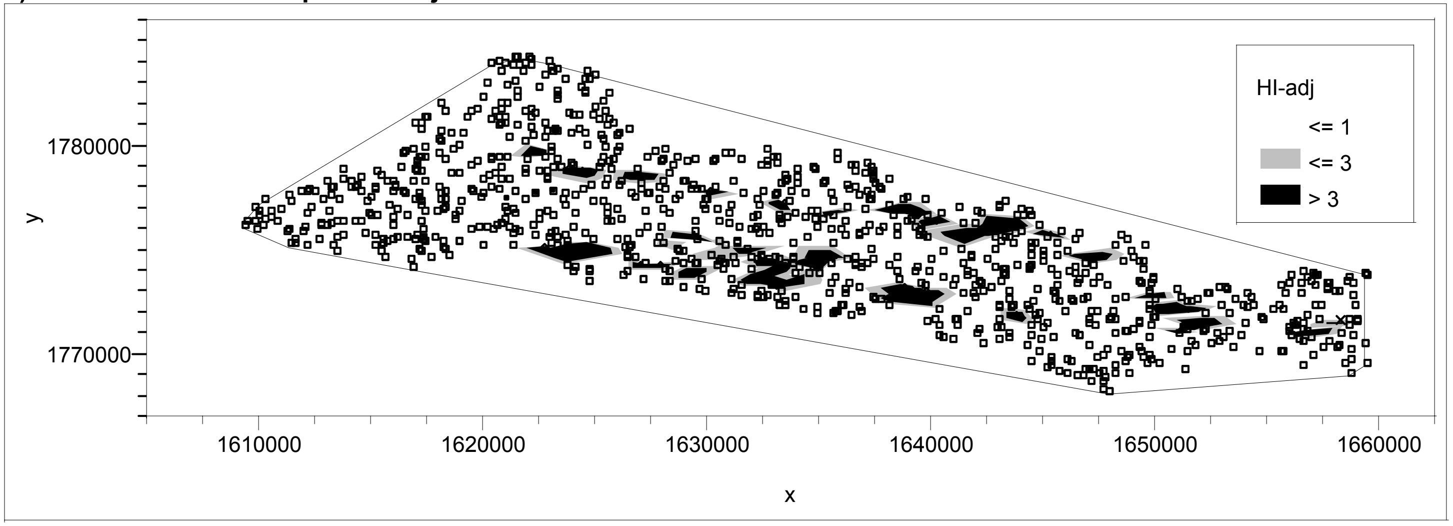


Figure 5-1. **Box plots showing distribution of adjusted (a and b) and unadjusted (c and d) HIs grouped by geographical areas for the deer mouse.**

a) Deer mouse contour plot for adjusted HI



b) Deer mouse contour plot for unadjusted HI

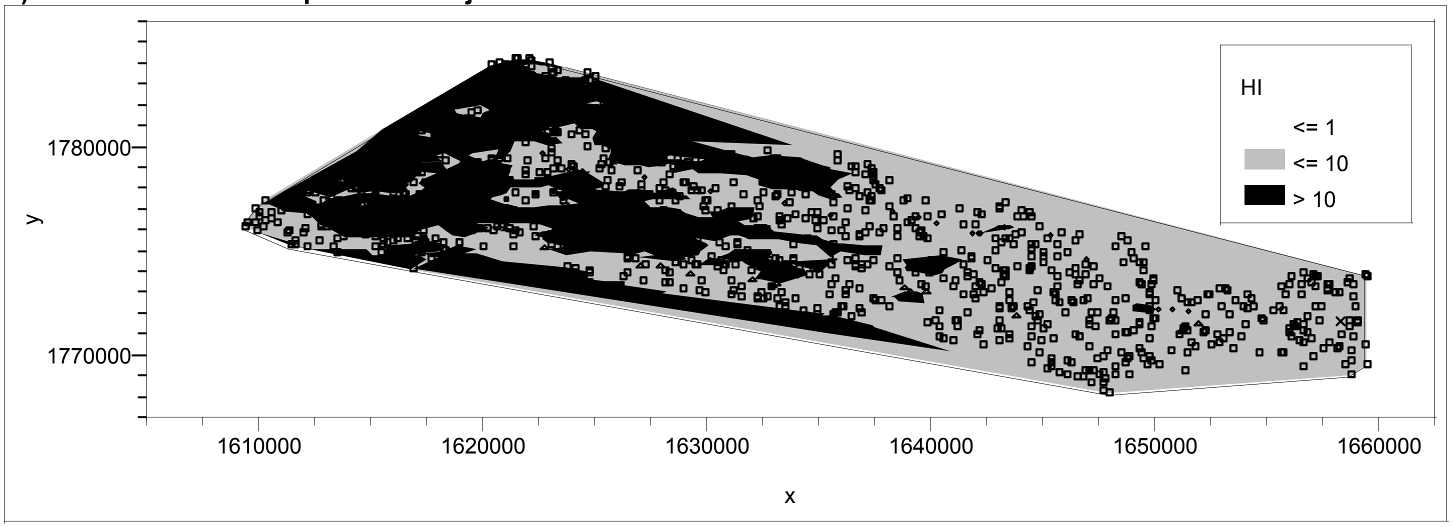


Figure 5-2. Contour plots of adjusted (a) and unadjusted (b) HIs for the deer mouse.

Table 15. Scenario 3c Adjusted HIs for Selected Nest Sites for (a) Deer Mouse, (b) Owl, and (c) Bluebird

(a) Deer Mouse

Column	Row	HI	Nest ID No.
351	464	1.54E+01	787
310	477	1.32E+01	421
197	486	1.23E+01	936
393	496	1.11E+01	95
527	445	8.67E+00	980
253	491	8.07E+00	791
186	531	7.30E+00	451
232	520	7.29E+00	40
261	513	7.28E+00	823
294	507	7.27E+00	181
315	502	7.27E+00	871
343	504	7.26E+00	742
354	501	7.26E+00	939
362	498	7.26E+00	464
378	493	7.26E+00	628
382	493	7.26E+00	454
381	493	7.26E+00	836
413	492	7.25E+00	865
429	481	7.25E+00	578
461	457	7.24E+00	225
468	457	7.24E+00	305
475	456	7.24E+00	412
287	480	7.11E+00	248
315	481	7.09E+00	986
457	463	6.91E+00	270
204	523	6.65E+00	884
187	485	6.33E+00	888
230	477	6.25E+00	413
239	477	6.23E+00	24
252	473	6.21E+00	242
292	475	6.21E+00	522
280	470	6.16E+00	903
398	453	6.15E+00	275
289	467	6.15E+00	455
358	464	6.15E+00	572
348	466	6.15E+00	990
291	468	6.15E+00	995
473	447	6.15E+00	408
471	445	6.15E+00	758
479	449	6.15E+00	812
277	484	5.55E+00	167
542	450	4.49E+00	911
294	478	4.43E+00	45
198	524	3.83E+00	361
240	487	3.79E+00	386
282	480	3.64E+00	139
Mean		6.77	
Std Dev		2.19	

(b) Mexican Spotted Owl

Column	Row	HI	Nest ID No.
197	477	4.38E+00	53
254	478	3.65E+00	50
239	477	3.57E+00	26
129	489	3.08E+00	33
189	490	2.91E+00	20
268	478	2.81E+00	13
271	465	2.54E+00	56
166	496	1.50E+00	22
267	462	1.49E+00	8
138	490	1.40E+00	4
136	481	1.23E+00	7
294	478	1.16E+00	47
169	499	1.04E+00	95
Mean		2.2	
Std Dev		1.1	

(c) Bluebird

Column	Row	HI	Nest ID No.
204	523	4.89E+01	957
190	487	2.61E+01	524
259	504	1.74E+01	546
197	488	1.25E+01	956
290	481	1.08E+01	172
305	473	9.96E+00	719
195	508	9.50E+00	779
187	485	9.42E+00	961
398	453	8.56E+00	295
473	447	8.46E+00	440
230	477	8.31E+00	445
239	477	8.10E+00	27
253	491	7.89E+00	858
252	473	7.81E+00	259
227	481	7.68E+00	303

Table 15 (c) cont.

Column	Row	HI	Nest ID No.
358	464	7.63E+00	618
471	445	7.54E+00	821
280	470	7.08E+00	976
289	467	7.01E+00	490
479	449	6.92E+00	880
351	464	6.89E+00	854
314	463	6.85E+00	940
442	444	6.77E+00	185
446	445	6.77E+00	299
447	445	6.77E+00	822
232	478	6.61E+00	165
472	447	6.46E+00	404
265	488	6.03E+00	709
298	480	5.84E+00	739
298	478	5.41E+00	160
542	450	5.37E+00	986
261	482	5.31E+00	734
474	446	5.08E+00	73
470	444	5.08E+00	835
362	498	5.02E+00	499
266	480	4.79E+00	980
294	507	4.70E+00	192
298	481	4.66E+00	770
475	456	4.57E+00	444
193	528	4.54E+00	219
232	520	4.51E+00	45

Column	Row	HI	Nest ID No.
268	486	4.48E+00	899
378	493	4.42E+00	682
261	513	4.41E+00	893
273	487	4.41E+00	690
382	493	4.40E+00	489
343	504	4.35E+00	805
276	511	4.27E+00	260
315	502	4.25E+00	943
468	457	4.09E+00	329
292	475	4.05E+00	565
381	493	4.05E+00	907
429	481	3.91E+00	625
461	457	3.79E+00	241
310	477	3.75E+00	454
186	531	3.73E+00	486
190	531	3.72E+00	914
307	476	3.62E+00	36
264	477	3.57E+00	234
294	478	3.35E+00	51
457	463	3.30E+00	289
519	445	3.22E+00	448
546	451	3.22E+00	496
408	496	3.17E+00	104
277	484	3.16E+00	178
Mean		6.69	
Std Dev		6.37	

Table A-2 has COPEC-specific HQs and summary statistics for the selected nest sites. For the deer mouse, only Tl and Sb had mean HQs>1.0. Analytes with mean HQs greater than 0.3 were Se and As. For the owl there were no mean HQs>1.0 and CN, Aroclor-1254, and Bis(2-ethylhexyl)phthalate had HQs>0.3. Only Aroclor-1254 had a mean HQ>1.0 for the bluebird but there were several COPECs with HIs>0.3: naphthalene, CN, Pb, V, Hg, and Zn. Tl and Sb had high background contributions to HIs, but since the HQs discussed in this paragraph exclude background some discussion is warranted. A risk screen conducted concurrently with the application of ECORSK.7 resulted in large HQs (>5) for, amongst other COPECs, Aroclor-1254, As, and Tl for the mammalian invertivore representative—the shrew. Other COPECs showing up in the screening study that are in common with the high-HQ COPECs in this study were Hg in the aerial invertivore (robin) and invertebrates; Sb, Se, Tl, and Zn in plants; and CN in the swallow. Tl has very low TRVs, which makes it conducive to high HQs. There are a few documented LANL sources of Tl. The HQ results for Sb and V can be partially explained by the relatively high DL that was used in place of non-detect results—there may be a few documented LANL sources, however Sb generally is not a major COPEC. Arsenic is not commonly associated with PRSs—spotty occurrences of relatively high HQs for As might be the result of variation in background levels. In sampling conducted following the Cerro Grande fire, CN was detected in Los Alamos and Pueblo Canyons. As with many industrial sites that used electrical transformers, sources of PCBs such as the Aroclor mixtures are known to have existed at LANL. Aroclors now exist largely as diffuse sources and they have previously shown up as dominant contributors to HIs (Gonzales et al. 2002). Metals such as Zn typically have had PRS sources at LANL but elevated levels also have been associated with runoff from the town site.

DISCUSSION

Some perspective of the meaning of the results can be achieved by 1) understanding decisions that were made regarding the selection of parameters used in the assessment and 2) comparing the results of our assessment to other modeling results or to the results of empirical studies. Table 16 identifies decisions that were made regarding the selection of parameters and how they might have impacted the results. A sensitivity analysis of the effect of parameter variation on ECORSK HI results conducted on the American peregrine falcon (*Falco peregrinus*) in 1997 established that, by far, TRV and BCF selection affect HI results the most (Gallegos et al. 1997b) and this continues to be the case. Since the time of assessments on T&E species in the late 1990s, LANL has developed a vigorous process (discussed in Methods) for the selection of TRVs and we believe that the TRV database is also reflective of the large majority of available primary and secondary literature on animal toxicological data. We consider the Adjusted Baseline (Scenario 3c), including Ecorisk Database R2.0 TRVs in combination with other, more protective parameters, to result in the most useful model results. The replacement of non-detects with DLs turned out to be an erroneous assumption, at least as proven with the COPEC naphthalene. Also, sampling is biased to areas that are known to contain or are highly suspected of containing elevated levels of contamination and these levels are assumed for entire grids. This conservatism results in an overestimate of HIs and HQs or added protection of the animals. The fact that TRVs are unavailable for up to 14 COPECs for the bird receptors was not of major concern because, considering the deer mouse for example, although antimony, titanium, and thallium were dominant contributors to the unadjusted HI, the majority of that contribution was from background sources. Large contributions from background sources are sometimes an indication that TRVs are very conservative, perhaps overly protective.

Table 16. Parameter and Assumption Selections for Calculating Risk from Contaminants and Subjective Binning of Effects on HIs

Conservative (overestimate risk)	Realistic	Nonconservative (underestimate risk)
Sampling on which HI calcs are based is biased to areas known or suspected of having elevated concentrations		
Nondetects replaced with the detection limit.		
Contamination level measured at sampling points assumed for entire 100- by 100-ft area of a grid cell, when in fact, sometimes, the contaminated area is less than the 10,000 ft^2 grid cell.		
All COPECs assumed to have same biological effect, therefore treated as additive.		
CS TRVs	GMM TRVs	HIs not estimated for contaminants for which TRVs not available
Assumed bioavailability of COPECs = 100%	Average, not maximum, COPEC concentrations in soil used	
Percent (%) of dietary food intake as soil = 5 for owl and bluebird.		

In 1997 ECORSK.4 was executed Lab-wide for the Mexican spotted owl and, although that assessment is not very comparable to the current one because so many of the parameters have changed, results were similar—the mean total HI (unadjusted) in 1997, 0.20, compares to the mean total HI (unadjusted) of 0.67 for the current assessment. The inclusion of background levels of COPECs in unsampled grid cells in the current assessment added to the HI in the current assessment.

CONCLUSIONS

The results of this assessment are valuable for enhancing the spatial and temporal coverage of empirical studies that were conducted concurrently. Given the uncertainty in toxicological values used worldwide, the main use of the results is as relative values. Few geographical areas of relatively high HIs originating from presumably anthropogenic sources of COPECs have been identified and should be investigated. Model results indicate that on average there is little if any potential for impact to the Mexican spotted owl and a small potential for impact to the deer mouse and Western bluebird from environmental contaminants. The higher values in the range of distribution of HIs indicate a moderate potential for impact to the mouse and bluebird in some areas of LANL and a small potential for impact to the owl in some areas of LANL; however, background sources of contaminants were the dominant contributors to the HIs. This is an indication that TRVs may be overly protective (too low) and/or that mean background values of COPECs were relatively high as the result of a few high values that went into the average. About 0.4% of deer mouse populations were predicted to have a moderate (HIs>10.0) level of potential impact from anthropogenic sources of environmental contamination and 5.4%

had a small (HI = 1–10) potential for impact. About 10.6% of the bluebird population could experience adverse impacts from anthropogenic sources of COPECs. Considering the conservatism injected into the assessment, there was good agreement between HIs/HQs in this study and HIs/HQs resulting from a screening study. Considering changes in parameters that have taken place since an ECORSK.4 assessment of the Mexican spotted owl in 1997, there was good agreement between HIs of the old study compared with HIs in the current study. Enabling the owl to forage to the full extent of its HR without restriction to the LAPCIR study area may have utility in future assessments. The Adjusted Baseline is the most reasonable scenario on which to base conclusions; it should serve as the ECORSK.7 baseline for the study area and is the scenario to which other assessments should be compared in the future.

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APPENDIX

Table A-1. R programming code and interpolation model input files. Input files are organized by subwatershed: DP Canyon (DPC), Upper Los Alamos Canyon (ULAC), Lower Los Alamos Canyon (LLAC), Acid Canyon (AC), reach ACS or South Fork of Acid Canyon (ACS), and Pueblo Canyon (PC).

```
interpolate.r <- function(cells, models)
{
# interpolate.r is used as function INTERPOLATE.R in R
# This function is used to calculate interpolated COPEC concentrations
# for ECORSK7 grid cells in LANL canyons
#  cells = data frame containing the cell data
#     $r = cell row number
#     $c = cell column number
#     $d = cell distance from Rio Grande
#    $xc = xcenter of cell [easting in ft]
#    $yc = ycenter of cell [northing in ft]
# models = data frame containing the analytes & interpolation model
paremeters
#   $cyn = canyon code [text]
#    $ac = analyte code [text]
#   $min = minimum distance that model applies
#   $max = maximum distance that model applies
#    $ln = lognormal flag [=0 not transformed; =1 log scale]
#   $int = intercept of model
# $slope = slope of model
# Randall Ryti - August 30, 2001; revised December 14, 2003
#.............................................................

# how many cells in the canyon
nc <- length(cells$d)

# how many analyte/model combinations for the canyon
nm <- length(models$min)

# print length of data frames
cat(nc," cells,",nm," models\n")

# initialize counters and arrays
i <- 0
k <- 0
sample.value <- rep(-1,nc*nm)
xcenter <- rep(-1,nc*nm)
ycenter <- rep(-1,nc*nm)
row.column <- rep("-",nc*nm)
analyte.code <- rep("-",nc*nm)
dist.rg <- rep(-1,nc*nm)

# outer loop on the models
  repeat
  {
     i <- i+1
     j <- 0
```

```
# inner loop on the cells
    repeat
    {
# print check value
      if (k/1000==round(k/1000,0) && k>0) cat(k,", ")
      j <- j+1
# test cell distance
      if (cells$d[j] >= models$min[i] && cells$d[j] < models$max[i])
        {
          k <- k+1
# interpolate analyte concentration for cells in range
          temp <- ifelse(
            models$ln[i]==0,
            models$int[i]+models$slope[i]*cells$d[j],
            exp(models$int[i]+models$slope[i]*cells$d[j]) )
# accumulate results
          sample.value[k] <- temp
          xcenter[k] <- cells$xc[j]
          ycenter[k] <- cells$yc[j]
          row.column[k] <- paste(cells$r[j],"-",cells$c[j],sep="")
          analyte.code[k] <- models$ac[i]
          dist.rg[k] <- cells$d[j]
        }
# exit inner loop
      if (j>=nc) break
    }
# exit outer loop
    if(i>=nm) break
  }
  cat("\n","k=",k,"\n")
  return(cbind(sample.value,     xcenter,     ycenter,     row.column,
analyte.code, dist.rg))
}
```

<u>file</u>: models_ac.txt

```
cyn,ac, min, max, ln, int, slope
"AC","SB",17.9,19.4,0,0.43176961,0
"AC","AS",17.9,19.4,0,2.91095811,0
"AC","BA",17.9,19.4,0,67.7051025,0
"AC","BE",17.9,19.4,0,0.50498841,0
"AC","B",17.9,19.4,0,1.2,0
"AC","CD",17.9,19.4,0,0.5564951,0
"AC","CR",17.9,19.4,0,-76.46714,4.5881624
"AC","CO",17.9,19.4,0,3.79318182,0
"AC","CU",17.9,19.4,0,11.5749153,0
"AC","CN(-1)",17.9,19.4,0,0.15,0
"AC","PB",17.9,19.4,0,-417.1568,26.663365
"AC","MN",17.9,19.4,0,348.44385,0
"AC","HG",17.9,18.4,0,0.441323,0
"AC","HG",18.41,19.4,0,0.036667,0
"AC","HGM",17.9,18.4,0,0.001857658,0
"AC","HGM",18.41,19.4,0,0.000154342,0
"AC","NI",17.9,19.4,0,5.22180927,0
"AC","SE",17.9,19.4,0,0.5540713,0
"AC","AG",17.9,19.4,0,0.64264528,0
"AC","TL",17.9,19.4,0,0.31246791,0
"AC","TI",17.9,19.4,0,240,0
"AC","U(total)",17.9,19.4,0,3.54448362,0
"AC","V",17.9,19.4,0,13.4856016,0
"AC","ZN",17.9,19.4,0,-834.1171,49.770943
"AC","83-32-9",17.9,19.4,0,-6.209032,0.3657121
"AC","56-55-3",17.9,19.4,0,-27.34876,1.5316487
"AC","50-32-8",17.9,19.4,0,-32.68708,1.8198131
"AC","205-99-2",17.9,19.4,0,-42.05511,2.3591765
"AC","191-24-2",17.9,19.4,0,-0.97991,0.0763554
"AC","218-01-9",17.9,19.4,0,-29.42182,1.6447515
"AC","206-44-0",17.9,19.4,0,-62.47733,3.4827213
"AC","86-73-7",17.9,19.4,0,-6.31856,0.3712998
"AC","91-20-3",17.9,19.4,0,-7.831983,0.4531531
"AC","85-01-8",17.9,19.4,0,-57.57394,3.2055145
"AC","129-00-0",17.9,19.4,0,-77.57639,4.3042141
"AC","11097-69-1",17.9,18.4,0,0.992378,0
"AC","11097-69-1",18.41,19.4,0,0.085833,0
"AC","11096-82-5",17.9,18.4,0,0.281711,0
"AC","11096-82-5",18.41,19.4,0,0.0945,0
"AC","72-55-9",17.9,19.4,0,-0.185858,0.0105601
"AC","50-29-3",17.9,19.4,0,-0.488823,0.0277358
"AC","60-57-1",17.9,19.4,0,-0.158464,0.0090349
"AC","72-20-8",17.9,19.4,0,-0.160407,0.0091306
"AC","7421-93-4",17.9,19.4,0,-0.1607,0.0091474
"AC","117-81-7",17.9,19.4,0,0.57693375,0
"AC","AM-241",18.41,19.4,0,0.186014,0
"AC","AM-241",17.9,18.4,0,12.88955,0
"AC","CS-137",18.41,19.4,0,0.286583,0
"AC","CS-137",17.9,18.4,0,4.781273,0
"AC","PU-239/240",19.06,19.4,0,0.061783,0
"AC","PU-239/240",18.41,19.05,0,0.368983,0
"AC","PU-239/240",17.9,18.4,1,-29.69563,1.8524264
"AC","TH-232",17.9,19.4,0,0.96,0
```

<u>file</u>: models_acs.txt

```
cyn,ac, min, max, ln, int, slope
"ACS","SB",18.3,18.7,0,0.20641176,0
"ACS","AS",18.3,18.7,0,1.88352941,0
"ACS","BA",18.3,18.7,0,40.4764706,0
"ACS","BE",18.3,18.7,0,0.38752941,0
"ACS","B",18.3,18.7,0,1.2,0
"ACS","CD",18.3,18.7,0,0.93164706,0
"ACS","CR",18.3,18.7,0,9.13705882,0
"ACS","CO",18.3,18.7,0,1.9,0
"ACS","CU",18.3,18.7,0,13.4511765,0
"ACS","CN(-1)",18.3,18.7,0,0.15,0
"ACS","PB",18.3,18.7,0,76.5882353,0
"ACS","MN",18.3,18.7,0,197.411765,0
"ACS","HG",18.3,18.7,0,0.46655556,0
"ACS","HGM",18.3,18.7,0,0.00196387,0
"ACS","NI",18.3,18.7,0,4.43117647,0
"ACS","SE",18.3,18.7,0,0.37158824,0
"ACS","AG",18.3,18.7,0,1.57882353,0
"ACS","TL",18.3,18.7,0,0.15123529,0
"ACS","TI",18.3,18.7,0,240,0
"ACS","U(total)",18.3,18.7,0,5.16933886,0
"ACS","V",18.3,18.7,0,8.16058824,0
"ACS","ZN",18.3,18.7,0,54.1764706,0
"ACS","83-32-9",18.3,18.7,0,0.394915,0
"ACS","56-55-3",18.3,18.7,0,0.45090625,0
"ACS","50-32-8",18.3,18.7,0,0.3848,0
"ACS","205-99-2",18.3,18.7,0,0.38243,0
"ACS","191-24-2",18.3,18.7,0,0.41493,0
"ACS","218-01-9",18.3,18.7,0,0.40848889,0
"ACS","206-44-0",18.3,18.7,0,0.36797,0
"ACS","86-73-7",18.3,18.7,0,0.39576,0
"ACS","91-20-3",18.3,18.7,0,0.413235,0
"ACS","85-01-8",18.3,18.7,0,0.36999,0
"ACS","129-00-0",18.3,18.7,0,0.49008421,0
"ACS","11097-69-1",18.3,18.7,0,0.17182105,0
"ACS","11096-82-5",18.3,18.7,0,0.04762632,0
"ACS","72-55-9",18.3,18.7,0,0.01396842,0
"ACS","50-29-3",18.3,18.7,0,0.04723158,0
"ACS","60-57-1",18.3,18.7,0,0.01046842,0
"ACS","72-20-8",18.3,18.7,0,0.00707368,0
"ACS","7421-93-4",18.3,18.7,0,0.00718947,0
"ACS","117-81-7",18.3,18.7,0,0.387735,0
"ACS","AM-241",18.3,18.7,0,3.11470588,0
"ACS","CS-137",18.3,18.7,0,1.21883333,0
"ACS","PU-239/240",18.3,18.7,0,114.6185,0
"ACS","TH-232",18.3,18.7,0,0.96,0
```

<u>file</u>: models_dpc.txt

```
cyn,ac, min, max, ln, int, slope
"DPC","SB",12.8,16.2,0,1.18463925,0
"DPC","AS",12.8,16.2,0,1.87179365,0
"DPC","BA",12.8,16.2,0,57.3137302,0
"DPC","BE",12.8,16.2,0,0.45624603,0
"DPC","B",12.8,16.2,0,2,0
"DPC","CD",12.8,16.2,0,0.18240476,0
"DPC","CR",12.8,16.2,0,-12.67642,1.3346708
"DPC","CO",12.8,16.2,0,2.65463492,0
"DPC","CU",12.8,16.2,0,8.4452381,0
"DPC","CN(-1)",12.8,16.2,0,0.15,0
"DPC","PB",12.8,16.2,0,-141.5939,13.092202
"DPC","MN",12.8,16.2,0,231.334286,0
"DPC","HG",12.8,16.2,0,0.04001508,0
"DPC","HGM",12.8,16.2,0,0.000168435,0
"DPC","NI",12.8,16.2,0,4.18175397,0
"DPC","SE",12.8,16.2,0,0.54885714,0
"DPC","AG",12.8,16.2,0,0.2934881,0
"DPC","TL",12.8,16.2,0,0.54078571,0
"DPC","TI",12.8,16.2,0,88.8,0
"DPC","U(total)",12.8,16.2,0,2.34379156,0
"DPC","V",12.8,16.2,0,10.0044048,0
"DPC","ZN",12.8,16.2,0,-118.8355,11.775961
"DPC","83-32-9",12.8,16.2,0,-6.055761,0.5309376
"DPC","56-55-3",12.8,16.2,0,-1.487568,0.1724676
"DPC","50-32-8",12.8,16.2,0,-3.769068,0.3421756
"DPC","205-99-2",12.8,16.2,0,-3.692927,0.3225197
"DPC","191-24-2",12.8,16.2,0,-6.800343,0.5873953
"DPC","218-01-9",12.8,16.2,0,-1.641146,0.1844619
"DPC","206-44-0",12.8,16.2,0,-4.549294,0.3858981
"DPC","86-73-7",12.8,16.2,0,-6.407569,0.5553593
"DPC","91-20-3",12.8,16.2,0,-5.072356,0.4595144
"DPC","85-01-8",12.8,16.2,0,-1.649036,0.1788783
"DPC","129-00-0",12.8,16.2,0,-9.283582,0.7284366
"DPC","11097-69-1",12.8,16.2,0,0.13838925,0
"DPC","11096-82-5",12.8,16.2,0,-0.424773,0.0362035
"DPC","72-55-9",12.8,16.2,0,0.02379583,0
"DPC","50-29-3",12.8,16.2,0,0.03373229,0
"DPC","60-57-1",12.8,16.2,0,0.02382333,0
"DPC","72-20-8",12.8,16.2,0,0.02382333,0
"DPC","7421-93-4",12.8,16.2,0,0.02382333,0
"DPC","117-81-7",12.8,16.2,0,1.29342566,0
"DPC","AM-241",14.61,16.2,0,0.11,0
"DPC","AM-241",12.8,14.6,1,-5.170518,0.5151775
"DPC","CS-137",14.61,16.2,0,0.254833,0
"DPC","CS-137",12.8,14.6,1,-3.024202,0.4851541
"DPC","PU-239/240",14.61,16.2,0,0.039294,0
"DPC","PU-239/240",12.8,14.6,0,24.981,-1.49949
"DPC","TH-232",12.8,16.2,0,2.11,0
```

file: **models_llac.txt**

```
cyn,ac, min, max, ln, int, slope
"LLAC","SB",5,8.2,0,1.80541369,0
"LLAC","AS",5,8.2,0,1.42565595,0
"LLAC","BA",5,8.2,0,79.0750119,0
"LLAC","BE",5,8.2,0,0.56090238,0
"LLAC","B",5,8.2,0,2.8,0
"LLAC","CD",5,8.2,0,0.21340714,0
"LLAC","CR",5,8.2,0,4.45160714,0
"LLAC","CO",5,8.2,0,2.65770238,0
"LLAC","CU",5,8.2,0,6.69963095,0
"LLAC","CN(-1)",5,8.2,0,0.77654762,0
"LLAC","PB",5,8.2,0,13.6565119,0
"LLAC","MN",5,8.2,0,307.119048,0
"LLAC","HG",5,8.2,0,0.02296435,0
"LLAC","HGM",5,8.2,0,9.66637E-05,0
"LLAC","NI",5,8.2,0,4.54402381,0
"LLAC","SE",5,8.2,0,0.41700714,0
"LLAC","AG",5,8.2,0,0.2306369,0
"LLAC","TL",5,8.2,0,0.35699167,0
"LLAC","TI",5,8.2,0,300.285714,0
"LLAC","U(total)",5,8.2,0,3.92383393,0
"LLAC","V",5,8.2,0,10.0271548,0
"LLAC","ZN",5,8.2,0,30.4286786,0
"LLAC","83-32-9",5,8.2,0,0.20844821,0
"LLAC","56-55-3",5,8.2,0,0.20857321,0
"LLAC","50-32-8",5,8.2,0,0.20844821,0
"LLAC","205-99-2",5,8.2,0,0.20844821,0
"LLAC","191-24-2",5,8.2,0,0.20844821,0
"LLAC","218-01-9",5,8.2,0,0.20900446,0
"LLAC","206-44-0",5,8.2,0,0.20951071,0
"LLAC","86-73-7",5,8.2,0,0.20654821,0
"LLAC","91-20-3",5,8.2,0,0.20844821,0
"LLAC","85-01-8",5,8.2,0,0.20741071,0
"LLAC","129-00-0",5,8.2,0,0.21017321,0
"LLAC","11097-69-1",5,8.2,0,0.035697,0
"LLAC","11096-82-5",5,8.2,0,0.0314381,0
"LLAC","72-55-9",5,8.2,0,0.00292029,0
"LLAC","50-29-3",5,8.2,0,0.00308695,0
"LLAC","60-57-1",5,8.2,0,0.00292029,0
"LLAC","72-20-8",5,8.2,0,0.00292029,0
"LLAC","7421-93-4",5,8.2,0,0.00292029,0
"LLAC","117-81-7",5,8.2,0,0.10594375,0
"LLAC","AM-241",5,8.2,1,-5.170518,0.5151775
"LLAC","CS-137",5,8.2,0,0.8458561,0
"LLAC","PU-239/240",5,8.2,1,-1.484954,0.3409558
"LLAC","TH-232",5,8.2,0,1.28571429,0
```

<u>file</u>: models_pc.txt

```
cyn,ac, min, max, ln, int, slope
"PC","SB",8,20,0,0.7301686,0
"PC","AS",8,20,0,2.28345625,0
"PC","BA",8,20,0,87.1167989,0
"PC","BE",8,20,0,0.65530433,0
"PC","B",8,20,0,2.12375,0
"PC","CD",8,20,0,0.21501798,0
"PC","CR",8,20,0,5.14024013,0
"PC","CO",8,20,0,3.35435348,0
"PC","CU",8,20,0,8.1507382,0
"PC","CN(-1)",8,20,0,0.292,0
"PC","PB",8,20,0,21.9957992,0
"PC","MN",8,20,0,468.02062,0
"PC","HG",8,20,0,-0.041973,0.0093915
"PC","HGM",8,20,0,-0.000177,0.0000395
"PC","NI",8,20,0,4.92584809,0
"PC","SE",8,20,0,0.53036706,0
"PC","AG",8,20,0,0.38463502,0
"PC","TL",8,20,0,0.63903129,0
"PC","TI",8,20,0,334.358333,0
"PC","U(total)",8,20,0,4.90164241,0
"PC","V",8,20,0,11.2004329,0
"PC","ZN",8,20,0,46.2774237,0
"PC","83-32-9",8,20,0,0.330675,0
"PC","56-55-3",8,20,0,0.38303056,0
"PC","50-32-8",8,20,0,0.41486944,0
"PC","205-99-2",8,20,0,0.44652222,0
"PC","191-24-2",8,20,0,0.35406389,0
"PC","218-01-9",8,20,0,0.3764,0
"PC","206-44-0",8,20,0,0.46446944,0
"PC","86-73-7",8,20,0,0.33327222,0
"PC","91-20-3",8,20,0,0.33043889,0
"PC","85-01-8",8,20,0,0.45756389,0
"PC","129-00-0",8,20,0,0.44333889,0
"PC","11097-69-1",8,20,0,0.03794583,0
"PC","11096-82-5",17.55,20,0,0.058889,0
"PC","11096-82-5",8,17.54,0,0.03523,0
"PC","72-55-9",8,20,0,0.00295508,0
"PC","50-29-3",8,20,0,0.00475056,0
"PC","60-57-1",8,20,0,0.00308008,0
"PC","72-20-8",8,20,0,0.0032405,0
"PC","7421-93-4",8,20,0,0.0032405,0
"PC","117-81-7",8,20,0,0.42046667,0
"PC","AM-241",18.07,20,0,0.019222,0
"PC","AM-241",14.87,18.065,0,1.232688,0
"PC","AM-241",10.16,14.865,0,0.119618,0
"PC","AM-241",8.91,10.155,0,0.732833,0
"PC","AM-241",8,8.905,0,0.135462,0
"PC","CS-137",8,20,0,0.92692156,0
"PC","PU-239/240",18.06,20,0,0.108889,0
"PC","PU-239/240",9.81,18.05,1,-3.959029,0.4092135
"PC","PU-239/240",8,9.805,1,-1.484954,0.3409558
"PC","TH-232",8,20,0,1.393875,0
```

file: models_ulac.txt

```
cyn,ac, min, max, ln, int, slope
"ULAC","SB",7.8,20,0,3.08303168,0
"ULAC","AS",7.8,20,0,1.62684642,0
"ULAC","BA",7.8,20,0,69.1520179,0
"ULAC","BE",7.8,20,0,0.62878994,0
"ULAC","B",7.8,20,0,1.42,0
"ULAC","CD",7.8,20,0,0.26533747,0
"ULAC","CR",7.8,20,0,6.27037879,0
"ULAC","CO",7.8,20,0,2.52493388,0
"ULAC","CU",7.8,20,0,8.79973829,0
"ULAC","CN(-1)",7.8,20,0,0.7275,0
"ULAC","PB",7.8,20,0,26.1715702,0
"ULAC","MN",7.8,20,0,302.20365,0
"ULAC","HG",7.8,20,0,0.06072149,0
"ULAC","HGM",7.8,20,0,0.000255595,0
"ULAC","NI",7.8,20,0,3.9684022,0
"ULAC","SE",7.8,20,0,0.54829959,0
"ULAC","AG",7.8,20,0,0.74400165,0
"ULAC","TL",7.8,20,0,0.2806708,0
"ULAC","TI",7.8,20,0,192.47,0
"ULAC","U(total)",7.8,20,0,4.18714665,0
"ULAC","V",7.8,20,0,8.87700413,0
"ULAC","ZN",7.8,20,0,44.5843664,0
"ULAC","83-32-9",7.8,20,0,0.46446389,0
"ULAC","56-55-3",7.8,20,0,0.36808333,0
"ULAC","50-32-8",7.8,20,0,0.36029028,0
"ULAC","205-99-2",7.8,20,0,0.38616319,0
"ULAC","191-24-2",7.8,20,0,0.45802778,0
"ULAC","218-01-9",7.8,20,0,0.37776389,0
"ULAC","206-44-0",7.8,20,0,0.43937847,0
"ULAC","86-73-7",7.8,20,0,0.45578889,0
"ULAC","91-20-3",7.8,20,0,0.45294444,0
"ULAC","85-01-8",7.8,20,0,0.39035069,0
"ULAC","129-00-0",7.8,20,0,1.17332639,0
"ULAC","11097-69-1",17.97,20,0,0.035697,0
"ULAC","11097-69-1",14.6,17.96,0,-0.841311,0.0598339
"ULAC","11097-69-1",7.8,14.595,0,0.035697,0
"ULAC","11096-82-5",15.91,20,0,0.05929,0
"ULAC","11096-82-5",10.2,15.9,0,0.199985,0
"ULAC","11096-82-5",7.8,10.195,0,0.05929,0
"ULAC","72-55-9",7.8,20,0,0.01234066,0
"ULAC","50-29-3",7.8,20,0,0.02445495,0
"ULAC","60-57-1",7.8,20,0,0.01220736,0
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"ULAC","TH-232",7.8,20,0,1.69287333,0
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file: cells_ac.txt

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509	167	19.31	1620788	1777471
509	168	19.28	1620888	1777471
510	168	19.26	1620888	1777571
510	169	19.23	1620988	1777571
510	170	19.2	1621088	1777571
510	171	19.17	1621188	1777571
510	172	19.14	1621288	1777571
510	173	19.11	1621388	1777571
511	173	19.1	1621388	1777671
511	174	19.07	1621488	1777671
511	175	19.04	1621588	1777671
511	176	19.01	1621688	1777671
512	176	19	1621688	1777771
512	177	18.96	1621788	1777771
512	178	18.93	1621888	1777771
512	179	18.9	1621988	1777771
512	180	18.87	1622088	1777771
512	182	18.79	1622288	1777771
512	183	18.76	1622388	1777771
512	184	18.73	1622488	1777771
512	185	18.7	1622588	1777771
512	186	18.67	1622688	1777771
512	187	18.63	1622788	1777771
513	180	18.86	1622088	1777871
513	181	18.83	1622188	1777871
513	182	18.8	1622288	1777871
513	183	18.77	1622388	1777871
513	187	18.62	1622788	1777871
513	188	18.59	1622888	1777871
513	189	18.56	1622988	1777871
513	190	18.53	1623088	1777871
514	190	18.52	1623088	1777971
514	191	18.49	1623188	1777971
514	192	18.46	1623288	1777971
515	192	18.44	1623288	1778071
515	193	18.41	1623388	1778071
515	194	18.38	1623488	1778071
515	195	18.35	1623588	1778071
515	196	18.32	1623688	1778071
515	197	18.29	1623788	1778071
516	197	18.28	1623788	1778171
516	198	18.25	1623888	1778171
516	199	18.24	1623988	1778171
517	199	18.21	1623988	1778271
517	200	18.19	1624088	1778271
518	200	18.16	1624088	1778371
518	201	18.15	1624188	1778371
519	201	18.12	1624188	1778471
519	202	18.11	1624288	1778471
520	202	18.08	1624288	1778571
521	202	18.05	1624288	1778671
521	203	18.03	1624388	1778671
522	203	18	1624388	1778771

file: cells_acs.txt

507	194	18.61	1623488	1777271
507	195	18.62	1623588	1777271
508	194	18.58	1623488	1777371
509	194	18.55	1623488	1777471
510	194	18.52	1623488	1777571
511	194	18.49	1623488	1777671
512	194	18.46	1623488	1777771
513	194	18.43	1623488	1777871
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file: cells_dpc.txt

r	c	d	xc	yc
491	264	15.44	1630488	1775671
491	265	15.44	1630588	1775671
491	266	15.41	1630688	1775671
491	267	15.38	1630788	1775671
491	268	15.35	1630888	1775671
491	269	15.32	1630988	1775671
490	269	15.31	1630988	1775571
490	270	15.28	1631088	1775571
490	271	15.25	1631188	1775571
490	272	15.21	1631288	1775571
490	273	15.18	1631388	1775571
489	273	15.17	1631388	1775471
489	274	15.14	1631488	1775471
489	275	15.11	1631588	1775471
489	276	15.08	1631688	1775471
489	277	15.05	1631788	1775471
488	277	15.04	1631788	1775371
488	278	15.01	1631888	1775371
488	279	14.98	1631988	1775371
487	279	14.96	1631988	1775271
487	280	14.93	1632088	1775271
487	281	14.9	1632188	1775271
487	282	14.87	1632288	1775271
486	282	14.86	1632288	1775171
486	283	14.83	1632388	1775171
486	284	14.8	1632488	1775171
486	285	14.77	1632588	1775171
486	286	14.74	1632688	1775171
486	287	14.71	1632788	1775171
486	288	14.68	1632888	1775171
485	288	14.66	1632888	1775071
485	289	14.63	1632988	1775071
484	289	14.62	1632988	1774971
484	290	14.59	1633088	1774971
483	290	14.58	1633088	1774871
483	291	14.55	1633188	1774871
483	292	14.52	1633288	1774871
483	293	14.49	1633388	1774871
482	293	14.47	1633388	1774771
482	294	14.44	1633488	1774771
482	295	14.41	1633588	1774771
482	296	14.38	1633688	1774771
482	297	14.35	1633788	1774771
482	298	14.32	1633888	1774771
482	299	14.29	1633988	1774771
482	300	14.26	1634088	1774771
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481	305	14.1	1634588	1774671
481	306	14.06	1634688	1774671
481	307	14.03	1634788	1774671
481	308	14	1634888	1774671
481	309	13.97	1634988	1774671
481	310	13.94	1635088	1774671
481	311	13.91	1635188	1774671
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481	315	13.81	1635588	1774671
480	315	13.78	1635588	1774571
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479	316	13.73	1635688	1774471
479	317	13.72	1635788	1774471
478	317	13.69	1635788	1774371
478	318	13.68	1635888	1774371
477	318	13.65	1635888	1774271
477	319	13.64	1635988	1774271
476	319	13.61	1635988	1774171
476	320	13.59	1636088	1774171
475	320	13.56	1636088	1774071
475	321	13.55	1636188	1774071
474	321	13.52	1636188	1773971
473	321	13.51	1636188	1773871
473	322	13.48	1636288	1773871
472	322	13.46	1636288	1773771
472	323	13.43	1636388	1773771
472	324	13.4	1636488	1773771
471	324	13.39	1636488	1773671
471	325	13.36	1636588	1773671
471	326	13.33	1636688	1773671
471	327	13.3	1636788	1773671
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470	331	13.16	1637188	1773571
470	332	13.13	1637288	1773571
469	332	13.12	1637288	1773471
469	333	13.09	1637388	1773471
469	334	13.08	1637488	1773471
468	334	13.05	1637488	1773371
467	334	13.02	1637488	1773271
466	334	12.99	1637488	1773171
466	335	12.97	1637588	1773171
465	335	12.94	1637588	1773071
492	254	15.79	1629488	1775771
492	255	15.76	1629588	1775771
492	256	15.73	1629688	1775771
492	257	15.70	1629788	1775771
492	258	15.67	1629888	1775771
492	259	15.64	1629988	1775771
492	260	15.61	1630088	1775771
492	261	15.57	1630188	1775771
492	262	15.54	1630288	1775771
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491	244	16.13	1628488	1775671
491	245	16.10	1628588	1775671
491	247	16.01	1628788	1775671
491	248	15.98	1628888	1775671
491	249	15.95	1628988	1775671
491	250	15.92	1629088	1775671
491	251	15.89	1629188	1775671
491	252	15.86	1629288	1775671
491	253	15.83	1629388	1775671
491	254	15.80	1629488	1775671
490	245	16.09	1628588	1775571
490	246	16.06	1628688	1775571
490	247	16.03	1628788	1775571

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451	489	7.73	1652988	1771671
450	489	7.7	1652988	1771571
450	490	7.69	1653088	1771571
449	490	7.66	1653088	1771471
448	490	7.65	1653088	1771371
448	491	7.62	1653188	1771371
447	491	7.6	1653188	1771271
447	492	7.57	1653288	1771271
446	492	7.56	1653288	1771171
446	493	7.53	1653388	1771171
446	494	7.5	1653488	1771171
446	495	7.47	1653588	1771171
445	495	7.46	1653588	1771071
445	496	7.43	1653688	1771071
445	497	7.4	1653788	1771071
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444	515	6.78	1655588	1770971
444	516	6.75	1655688	1770971
445	516	6.74	1655688	1771071
445	517	6.71	1655788	1771071
445	518	6.68	1655888	1771071
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446	521	6.58	1656188	1771171
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443	524	6.45	1656488	1770871
443	525	6.42	1656588	1770871
443	526	6.39	1656688	1770871
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444	527	6.34	1656788	1770971
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445	528	6.3	1656888	1771071
445	529	6.27	1656988	1771071
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445	538	5.97	1657888	1771071
445	539	5.96	1657988	1771071
446	539	5.93	1657988	1771171
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447	540	5.88	1658088	1771271
447	541	5.87	1658188	1771271
448	541	5.84	1658188	1771371
449	541	5.83	1658188	1771471
449	542	5.8	1658288	1771471
450	542	5.78	1658288	1771571
450	543	5.75	1658388	1771571
450	544	5.72	1658488	1771571
451	544	5.71	1658488	1771671
451	545	5.68	1658588	1771671
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453	548	5.56	1658888	1771871
454	548	5.55	1658888	1771971
454	549	5.52	1658988	1771971
454	550	5.49	1659088	1771971
455	550	5.48	1659088	1772071
455	551	5.45	1659188	1772071
455	552	5.42	1659288	1772071
456	552	5.4	1659288	1772171
456	553	5.37	1659388	1772171
456	554	5.34	1659488	1772171
456	555	5.33	1659588	1772171
458	555	5.3	1659588	1772371
457	555	5.3	1659588	1772271

file: cells_pc.txt

r	c	d	xc	yc
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526	148	19.96	1618888	1779171
526	149	19.95	1618988	1779171
527	149	19.92	1618988	1779271
528	149	19.9	1618988	1779371
528	150	19.87	1619088	1779371
528	151	19.84	1619188	1779371
528	152	19.81	1619288	1779371
529	152	19.8	1619288	1779471
529	153	19.77	1619388	1779471
530	153	19.76	1619388	1779571
530	154	19.73	1619488	1779571
530	155	19.7	1619588	1779571
531	155	19.68	1619588	1779671
531	156	19.65	1619688	1779671
531	157	19.62	1619788	1779671
531	158	19.59	1619888	1779671
532	158	19.58	1619888	1779771
532	159	19.55	1619988	1779771
532	160	19.52	1620088	1779771
531	160	19.5	1620088	1779671
531	161	19.47	1620188	1779671
531	162	19.44	1620288	1779671
532	162	19.43	1620288	1779771
532	163	19.4	1620388	1779771
532	164	19.37	1620488	1779771
533	164	19.36	1620488	1779871
533	165	19.33	1620588	1779871
532	166	19.31	1620688	1779771
533	166	19.3	1620688	1779871
532	167	19.28	1620788	1779771
533	167	19.27	1620788	1779871
533	168	19.24	1620888	1779871
533	169	19.21	1620988	1779871
533	170	19.17	1621088	1779871
533	171	19.14	1621188	1779871
533	172	19.11	1621288	1779871
533	173	19.08	1621388	1779871
534	173	19.07	1621388	1779971
535	174	19.05	1621488	1780071
534	174	19.04	1621488	1779971
535	175	19.02	1621588	1780071
534	175	19.01	1621588	1779971
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533	177	18.94	1621788	1779871
533	178	18.91	1621888	1779871
533	179	18.88	1621988	1779871
532	179	18.86	1621988	1779771
532	180	18.83	1622088	1779771
532	181	18.8	1622188	1779771
533	181	18.79	1622188	1779871
533	182	18.76	1622288	1779871
533	183	18.73	1622388	1779871
533	184	18.7	1622488	1779871
532	184	18.69	1622488	1779771
532	185	18.65	1622588	1779771
531	185	18.64	1622588	1779671
531	186	18.61	1622688	1779671
531	187	18.58	1622788	1779671
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530	189	18.51	1622988	1779571
530	190	18.49	1623088	1779571
529	190	18.46	1623088	1779471
529	191	18.45	1623188	1779471
528	191	18.42	1623188	1779371
527	191	18.41	1623188	1779271
527	192	18.38	1623288	1779271
526	192	18.37	1623288	1779171
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524	197	18.19	1623788	1778971
524	198	18.16	1623888	1778971
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524	200	18.1	1624088	1778971
524	201	18.07	1624188	1778971
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523	202	18.02	1624288	1778871
523	203	17.99	1624388	1778871
523	204	17.96	1624488	1778871
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523	206	17.9	1624688	1778871
523	207	17.87	1624788	1778871
523	208	17.84	1624888	1778871
522	208	17.83	1624888	1778771
522	209	17.8	1624988	1778771
522	210	17.77	1625088	1778771
521	210	17.75	1625088	1778671
521	211	17.72	1625188	1778671
521	212	17.69	1625288	1778671
521	213	17.66	1625388	1778671
521	214	17.63	1625488	1778671
521	215	17.6	1625588	1778671
521	216	17.57	1625688	1778671
520	216	17.56	1625688	1778571
520	217	17.53	1625788	1778571
520	218	17.5	1625888	1778571
520	219	17.47	1625988	1778571
521	219	17.45	1625988	1778671
521	220	17.42	1626088	1778671
521	221	17.39	1626188	1778671
521	222	17.36	1626288	1778671
520	222	17.35	1626288	1778571
520	223	17.32	1626388	1778571
520	224	17.29	1626488	1778571
519	225	17.27	1626588	1778471
520	225	17.26	1626588	1778571
519	226	17.24	1626688	1778471
520	226	17.23	1626688	1778571
520	227	17.2	1626788	1778571
520	228	17.17	1626888	1778571
520	229	17.14	1626988	1778571
519	229	17.12	1626988	1778471
519	230	17.09	1627088	1778471
519	231	17.06	1627188	1778471
519	232	17.05	1627288	1778471
520	232	17.02	1627288	1778571
521	232	17.01	1627288	1778671
521	233	16.98	1627388	1778671
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520	234	16.93	1627488	1778571
520	235	16.9	1627588	1778571
519	236	16.89	1627688	1778471
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520	237	16.84	1627788	1778571
520	238	16.81	1627888	1778571
520	239	16.78	1627988	1778571
520	240	16.75	1628088	1778571
520	241	16.72	1628188	1778571

520	242	16.69	1628288	1778571	508	295	14.87	1633588	1777371
520	243	16.66	1628388	1778571	508	296	14.84	1633688	1777371
520	244	16.63	1628488	1778571	508	297	14.81	1633788	1777371
519	244	16.62	1628488	1778471	508	298	14.78	1633888	1777371
519	245	16.59	1628588	1778471	508	299	14.75	1633988	1777371
519	246	16.56	1628688	1778471	509	300	14.73	1634088	1777471
518	246	16.54	1628688	1778371	508	300	14.72	1634088	1777371
518	247	16.51	1628788	1778371	509	301	14.7	1634188	1777471
518	248	16.48	1628888	1778371	508	301	14.69	1634188	1777371
519	248	16.47	1628888	1778471	508	302	14.66	1634288	1777371
519	249	16.44	1628988	1778471	508	303	14.63	1634388	1777371
519	250	16.41	1629088	1778471	507	303	14.62	1634388	1777271
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488	180	18.06	1622088	1775371
487	180	18.04	1622088	1775271
487	181	18.01	1622188	1775271
487	182	17.98	1622288	1775271
486	182	17.97	1622288	1775171
486	183	17.94	1622388	1775171
486	184	17.91	1622488	1775171
486	185	17.88	1622588	1775171
485	185	17.87	1622588	1775071
485	186	17.83	1622688	1775071
485	187	17.8	1622788	1775071
484	187	17.79	1622788	1774971
484	188	17.76	1622888	1774971
484	189	17.73	1622988	1774971
483	189	17.72	1622988	1774871
483	190	17.69	1623088	1774871
483	191	17.66	1623188	1774871
483	192	17.63	1623288	1774871
483	193	17.6	1623388	1774871
483	194	17.57	1623488	1774871
482	194	17.55	1623488	1774771
482	195	17.52	1623588	1774771
482	196	17.49	1623688	1774771
481	196	17.48	1623688	1774671
481	197	17.45	1623788	1774671
481	198	17.42	1623888	1774671
481	199	17.39	1623988	1774671
480	199	17.38	1623988	1774571
480	200	17.34	1624088	1774571
480	201	17.31	1624188	1774571
480	202	17.28	1624288	1774571
480	203	17.25	1624388	1774571
480	204	17.22	1624488	1774571
480	205	17.19	1624588	1774571
480	206	17.16	1624688	1774571
479	206	17.15	1624688	1774471
479	207	17.12	1624788	1774471
479	208	17.09	1624888	1774471
478	209	17.07	1624988	1774371
479	209	17.06	1624988	1774471
478	210	17.04	1625088	1774371
479	210	17.03	1625088	1774471
479	211	17	1625188	1774471
479	212	16.97	1625288	1774471
479	213	16.94	1625388	1774471
478	213	16.92	1625388	1774371
478	214	16.89	1625488	1774371
478	215	16.86	1625588	1774371
478	216	16.83	1625688	1774371
478	217	16.8	1625788	1774371
478	218	16.77	1625888	1774371
478	219	16.74	1625988	1774371
478	220	16.71	1626088	1774371
478	221	16.68	1626188	1774371
478	222	16.65	1626288	1774371
478	223	16.62	1626388	1774371
478	224	16.59	1626488	1774371
478	225	16.56	1626588	1774371
478	226	16.53	1626688	1774371
477	226	16.51	1626688	1774271
477	227	16.48	1626788	1774271
477	228	16.45	1626888	1774271
477	229	16.42	1626988	1774271
477	230	16.39	1627088	1774271
477	231	16.36	1627188	1774271
477	232	16.33	1627288	1774271
477	233	16.3	1627388	1774271

477	234	16.27	1627488	1774271	468	290	14.42	1633088	1773371
477	235	16.24	1627588	1774271	468	291	14.39	1633188	1773371
477	236	16.21	1627688	1774271	468	292	14.36	1633288	1773371
477	237	16.18	1627788	1774271	467	292	14.35	1633288	1773271
477	238	16.15	1627888	1774271	467	293	14.32	1633388	1773271
477	239	16.12	1627988	1774271	466	293	14.31	1633388	1773171
477	240	16.09	1628088	1774271	466	294	14.28	1633488	1773171
477	241	16.06	1628188	1774271	466	295	14.25	1633588	1773171
477	242	16.03	1628288	1774271	466	296	14.22	1633688	1773171
476	242	16.01	1628288	1774171	466	297	14.19	1633788	1773171
476	243	15.98	1628388	1774171	466	298	14.16	1633888	1773171
476	244	15.95	1628488	1774171	466	299	14.13	1633988	1773171
477	244	15.94	1628488	1774271	466	300	14.1	1634088	1773171
477	245	15.91	1628588	1774271	465	300	14.08	1634088	1773071
477	246	15.88	1628688	1774271	465	301	14.05	1634188	1773071
476	246	15.87	1628688	1774171	465	302	14.02	1634288	1773071
476	247	15.84	1628788	1774171	465	303	13.99	1634388	1773071
476	248	15.81	1628888	1774171	465	304	13.96	1634488	1773071
476	249	15.78	1628988	1774171	465	305	13.93	1634588	1773071
475	249	15.76	1628988	1774071	465	306	13.9	1634688	1773071
475	250	15.73	1629088	1774071	465	307	13.87	1634788	1773071
474	250	15.72	1629088	1773971	464	307	13.86	1634788	1772971
474	251	15.69	1629188	1773971	464	308	13.83	1634888	1772971
473	252	15.67	1629288	1773871	464	309	13.8	1634988	1772971
474	252	15.66	1629288	1773971	464	310	13.76	1635088	1772971
473	253	15.64	1629388	1773871	464	311	13.73	1635188	1772971
474	253	15.63	1629388	1773971	463	311	13.72	1635188	1772871
474	254	15.6	1629488	1773971	463	312	13.69	1635288	1772871
474	255	15.57	1629588	1773971	462	312	13.68	1635288	1772771
473	255	15.55	1629588	1773871	462	313	13.65	1635388	1772771
473	256	15.52	1629688	1773871	462	314	13.62	1635488	1772771
473	257	15.49	1629788	1773871	462	315	13.59	1635588	1772771
473	258	15.46	1629888	1773871	461	315	13.57	1635588	1772671
473	259	15.43	1629988	1773871	461	316	13.54	1635688	1772671
472	259	15.42	1629988	1773771	461	317	13.51	1635788	1772671
472	260	15.39	1630088	1773771	461	318	13.48	1635888	1772671
472	261	15.36	1630188	1773771	461	319	13.45	1635988	1772671
471	261	15.35	1630188	1773671	461	320	13.42	1636088	1772671
471	262	15.32	1630288	1773671	460	320	13.41	1636088	1772571
471	263	15.29	1630388	1773671	460	321	13.38	1636188	1772571
471	264	15.26	1630488	1773671	460	322	13.35	1636288	1772571
471	265	15.22	1630588	1773671	459	323	13.33	1636388	1772471
471	266	15.19	1630688	1773671	458	323	13.33	1636388	1772371
471	267	15.16	1630788	1773671	460	323	13.32	1636388	1772571
471	268	15.13	1630888	1773671	460	324	13.29	1636488	1772571
471	269	15.1	1630988	1773671	460	325	13.26	1636588	1772571
471	270	15.07	1631088	1773671	460	326	13.23	1636688	1772571
471	271	15.04	1631188	1773671	460	327	13.2	1636788	1772571
471	272	15.01	1631288	1773671	460	328	13.17	1636888	1772571
471	273	14.98	1631388	1773671	460	329	13.14	1636988	1772571
471	274	14.95	1631488	1773671	461	329	13.12	1636988	1772671
471	275	14.92	1631588	1773671	461	330	13.09	1637088	1772671
471	276	14.89	1631688	1773671	461	331	13.06	1637188	1772671
471	277	14.86	1631788	1773671	462	331	13.05	1637188	1772771
471	278	14.83	1631888	1773671	462	332	13.02	1637288	1772771
471	279	14.8	1631988	1773671	463	332	13.01	1637288	1772871
471	280	14.77	1632088	1773671	463	333	12.98	1637388	1772871
470	280	14.75	1632088	1773571	463	334	12.94	1637488	1772871
470	281	14.72	1632188	1773571	464	334	12.93	1637488	1772971
470	282	14.69	1632288	1773571	464	335	12.9	1637588	1772971
469	282	14.68	1632288	1773471	464	336	12.87	1637688	1772971
469	283	14.65	1632388	1773471	464	337	12.84	1637788	1772971
469	284	14.62	1632488	1773471	464	338	12.81	1637888	1772971
469	285	14.59	1632588	1773471	465	338	12.8	1637888	1773071
469	286	14.56	1632688	1773471	465	339	12.77	1637988	1773071
469	287	14.53	1632788	1773471	465	340	12.74	1638088	1773071
468	287	14.52	1632788	1773371	465	341	12.71	1638188	1773071
468	288	14.49	1632888	1773371	465	342	12.68	1638288	1773071
467	289	14.47	1632988	1773271	465	343	12.65	1638388	1773071
468	289	14.46	1632988	1773371	465	344	12.61	1638488	1773071
467	290	14.44	1633088	1773271	465	345	12.58	1638588	1773071

465	346	12.55	1638688	1773071
466	347	12.54	1638788	1773171
465	347	12.52	1638788	1773071
466	348	12.51	1638888	1773171
465	348	12.49	1638888	1773071
465	349	12.46	1638988	1773071
465	350	12.43	1639088	1773071
464	350	12.42	1639088	1772971
464	351	12.39	1639188	1772971
464	352	12.36	1639288	1772971
464	353	12.33	1639388	1772971
464	354	12.3	1639488	1772971
464	355	12.27	1639588	1772971
464	356	12.24	1639688	1772971
464	357	12.21	1639788	1772971
464	358	12.18	1639888	1772971
464	359	12.15	1639988	1772971
464	360	12.11	1640088	1772971
463	360	12.1	1640088	1772871
463	361	12.07	1640188	1772871
463	362	12.04	1640288	1772871
462	362	12.03	1640288	1772771
462	363	12	1640388	1772771
462	364	11.97	1640488	1772771
461	364	11.95	1640488	1772671
461	365	11.92	1640588	1772671
461	366	11.89	1640688	1772671
462	366	11.88	1640688	1772771
462	367	11.85	1640788	1772771
462	368	11.82	1640888	1772771
462	369	11.79	1640988	1772771
462	370	11.76	1641088	1772771
461	370	11.75	1641088	1772671
461	371	11.72	1641188	1772671
461	372	11.69	1641288	1772671
460	372	11.67	1641288	1772571
460	373	11.64	1641388	1772571
460	374	11.61	1641488	1772571
460	375	11.58	1641588	1772571
460	376	11.55	1641688	1772571
460	377	11.52	1641788	1772571
459	377	11.51	1641788	1772471
459	378	11.48	1641888	1772471
459	379	11.45	1641988	1772471
458	379	11.43	1641988	1772371
458	380	11.4	1642088	1772371
458	381	11.37	1642188	1772371
458	382	11.34	1642288	1772371
458	383	11.31	1642388	1772371
457	383	11.3	1642388	1772271
457	384	11.27	1642488	1772271
457	385	11.24	1642588	1772271
456	385	11.23	1642588	1772171
456	386	11.2	1642688	1772171
456	387	11.17	1642788	1772171
456	388	11.13	1642888	1772171
455	388	11.12	1642888	1772071
455	389	11.09	1642988	1772071
455	390	11.06	1643088	1772071
455	391	11.03	1643188	1772071
455	392	11	1643288	1772071
455	393	10.97	1643388	1772071
455	394	10.94	1643488	1772071
455	395	10.91	1643588	1772071
455	396	10.88	1643688	1772071
455	397	10.85	1643788	1772071
455	398	10.84	1643888	1772071
454	398	10.8	1643888	1771971
453	398	10.79	1643888	1771871
453	399	10.76	1643988	1771871
453	400	10.73	1644088	1771871

452	400	10.72	1644088	1771771
452	401	10.69	1644188	1771771
452	402	10.66	1644288	1771771
452	403	10.63	1644388	1771771
452	404	10.6	1644488	1771771
452	405	10.57	1644588	1771771
452	406	10.54	1644688	1771771
452	407	10.51	1644788	1771771
452	408	10.47	1644888	1771771
452	409	10.44	1644988	1771771
452	410	10.41	1645088	1771771
452	411	10.38	1645188	1771771
452	412	10.35	1645288	1771771
451	412	10.34	1645288	1771671
451	413	10.31	1645388	1771671
451	414	10.28	1645488	1771671
451	415	10.25	1645588	1771671
450	415	10.24	1645588	1771571
450	416	10.21	1645688	1771571
449	416	10.19	1645688	1771471
449	417	10.16	1645788	1771471
449	418	10.13	1645888	1771471
448	418	10.12	1645888	1771371
448	419	10.09	1645988	1771371
448	420	10.06	1646088	1771371
448	421	10.03	1646188	1771371
448	422	10	1646288	1771371
448	423	9.97	1646388	1771371
448	424	9.94	1646488	1771371
448	425	9.91	1646588	1771371
447	425	9.89	1646588	1771271
447	426	9.86	1646688	1771271
446	426	9.85	1646688	1771171
446	427	9.82	1646788	1771171
446	428	9.79	1646888	1771171
445	428	9.78	1646888	1771071
445	429	9.75	1646988	1771071
445	430	9.72	1647088	1771071
444	430	9.7	1647088	1770971
444	431	9.67	1647188	1770971
444	432	9.64	1647288	1770971
444	433	9.61	1647388	1770971
444	434	9.58	1647488	1770971
444	435	9.55	1647588	1770971
444	436	9.52	1647688	1770971
444	437	9.49	1647788	1770971
443	437	9.48	1647788	1770871
443	438	9.45	1647888	1770871
443	439	9.42	1647988	1770871
443	440	9.39	1648088	1770871
443	441	9.36	1648188	1770871
443	442	9.32	1648288	1770871
443	443	9.29	1648388	1770871
444	443	9.28	1648388	1770971
444	444	9.25	1648488	1770971
444	445	9.22	1648588	1770971
444	446	9.19	1648688	1770971
444	447	9.16	1648788	1770971
443	447	9.15	1648788	1770871
443	448	9.12	1648888	1770871
443	449	9.09	1648988	1770871
443	450	9.06	1649088	1770871
443	451	9.03	1649188	1770871
443	452	8.99	1649288	1770871
444	452	8.98	1649288	1770971
444	453	8.95	1649388	1770971
444	454	8.92	1649488	1770971
444	455	8.89	1649588	1770971
444	456	8.86	1649688	1770971
444	457	8.83	1649788	1770971
443	457	8.82	1649788	1770871

443	458	8.79	1649888	1770871
443	459	8.76	1649988	1770871
444	459	8.74	1649988	1770971
444	460	8.71	1650088	1770971
444	461	8.68	1650188	1770971
444	462	8.65	1650288	1770971
444	463	8.62	1650388	1770971
444	464	8.59	1650488	1770971
444	465	8.56	1650588	1770971
444	466	8.53	1650688	1770971
444	467	8.5	1650788	1770971
444	468	8.47	1650888	1770971
444	469	8.44	1650988	1770971
445	469	8.43	1650988	1771071
445	470	8.4	1651088	1771071
445	471	8.37	1651188	1771071
446	471	8.35	1651188	1771171
446	472	8.32	1651288	1771171
446	473	8.29	1651388	1771171
447	473	8.28	1651388	1771271
447	474	8.25	1651488	1771271
447	475	8.22	1651588	1771271
448	475	8.21	1651588	1771371
448	476	8.17	1651688	1771371
448	477	8.14	1651788	1771371
449	477	8.13	1651788	1771471
449	478	8.1	1651888	1771471
449	479	8.07	1651988	1771471
449	480	8.04	1652088	1771471
450	480	8.03	1652088	1771571
450	481	8	1652188	1771571
450	482	7.97	1652288	1771571
451	482	7.95	1652288	1771671
451	483	7.92	1652388	1771671
451	484	7.89	1652488	1771671
451	485	7.86	1652588	1771671
452	485	7.85	1652588	1771771
452	486	7.82	1652688	1771771

Table A-2. COPEC-Specific HQs Corresponding to Selected Nest Sites in Table 15.

a) Deer Mouse

Nest Site Col-Row	Acenaphthene	Americium 241	Antimony	Aroclor 1254	Aroclor 1260	Arsenic	Barium	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(g,h,l) perylene	Beryllium
186-531	1.12E-03	0.00E+00	4.12E-01	3.81E-02	2.62E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
187-485	1.57E-03	9.21E-09	4.72E+00	2.25E-01	2.64E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
197-486	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.96E-01	1.22E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
198-524	1.12E-03	0.00E+00	0.00E+00	3.81E-02	2.62E-03	6.03E-01	1.21E-01	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.93E-02
204-523	8.62E-04	1.32E-07	6.18E-01	2.02E-02	1.77E-03	5.15E-01	0.00E+00	1.50E-01	4.90E-02	1.55E-02	1.31E-02	0.00E+00
230-477	1.57E-03	9.21E-09	4.72E+00	1.40E-01	2.64E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
232-520	1.12E-03	1.32E-07	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
239-477	1.57E-03	9.21E-09	4.72E+00	1.24E-01	2.64E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
240-487	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E+00	3.93E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
252-473	1.57E-03	9.21E-09	4.72E+00	9.68E-02	8.89E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
253-491	7.94E-03	9.21E-09	1.24E+00	1.39E-01	6.60E-03	1.65E-02	0.00E+00	2.27E-01	8.03E-02	1.70E-02	8.74E-02	0.00E+00
261-513	1.12E-03	1.32E-07	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
277-484	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.33E-02	2.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.14E-01
280-470	1.57E-03	9.21E-09	4.72E+00	4.15E-02	8.89E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
282-480	0.00E+00	4.95E-08	0.00E+00	0.00E+00	0.00E+00	2.22E-01	2.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
287-480	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.10E+00	4.60E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-01
289-467	1.57E-03	9.21E-09	4.72E+00	3.59E-02	8.89E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
291-468	1.57E-03	9.21E-09	4.72E+00	3.59E-02	8.89E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
292-475	0.00E+00	5.93E-08	0.00E+00	0.00E+00	4.45E-02	1.36E+00	5.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.09E-02
294-478	0.00E+00	5.64E-07	0.00E+00	0.00E+00	0.00E+00	2.04E+00	5.53E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
294-507	1.12E-03	1.32E-07	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
310-477	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.04E+00	3.17E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E+00
315-481	4.31E-03	7.63E-07	1.24E+00	1.39E-01	3.34E-03	1.65E-02	0.00E+00	1.63E-01	4.66E-02	9.16E-03	4.59E-02	0.00E+00
315-502	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
343-504	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
348-466	1.57E-03	3.89E-07	4.72E+00	3.59E-02	8.89E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
351-464	1.03E-03	1.15E-06	1.36E+01	3.65E-02	2.18E-03	6.59E-02	0.00E+00	3.17E-02	9.43E-03	3.46E-03	1.26E-02	0.00E+00
354-501	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
358-464	1.57E-03	3.28E-07	4.72E+00	3.59E-02	8.89E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
362-498	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
378-493	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
381-493	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
382-493	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
393-496	1.12E-03	4.67E-08	0.00E+00	3.81E-02	1.57E-03	0.00E+00	0.00E+00	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.75E-03
398-453	1.57E-03	1.59E-07	4.72E+00	3.59E-02	8.89E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
413-492	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
429-481	1.12E-03	1.03E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
457-463	1.12E-03	1.80E-08	0.00E+00	3.22E-02	1.42E-03	3.43E-01	9.52E-03	6.38E-03	1.61E-02	3.98E-03	1.16E-02	1.58E-02
461-457	1.12E-03	7.75E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
468-457	1.12E-03	1.20E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
471-445	1.57E-03	4.36E-08	4.72E+00	3.59E-02	2.64E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
473-447	1.57E-03	4.15E-08	4.72E+00	3.59E-02	2.64E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
475-456	1.12E-03	1.20E-08	4.12E-01	3.81E-02	1.57E-03	2.31E-01	5.41E-02	6.98E-02	2.02E-02	5.37E-03	1.24E-02	1.15E-02
479-449	1.57E-03	3.70E-08	4.72E+00	3.59E-02	2.64E-03	0.00E+00	1.77E-02	6.71E-02	1.76E-02	4.65E-03	1.60E-02	6.80E-03
527-445	0.00E+00	6.71E-08	8.04E+00	4.12E-02	1.82E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
542-450	7.04E-04	9.38E-09	2.38E+00	3.59E-02	1.40E-03	0.00E+00	3.78E-02	3.80E-02	1.02E-02	2.51E-03	7.29E-03	0.00E+00
Mean	1.23E-03	9.83E-08	2.07E+00	4.45E-02	3.73E-03	3.28E-01	1.90E-01	5.97E-02	1.75E-02	4.54E-03	1.32E-02	8.81E-02
Std. Dev.	1.25E-03	2.19E-07	2.81E+00	4.39E-02	6.77E-03	5.45E-01	5.56E-01	4.36E-02	1.40E-02	3.34E-03	1.36E-02	4.43E-01

Table A-2 (a). cont.

Nest Site Col-Row	Bis(2-ethylhexyl) phthalate	Boron	Cadmium	Cesium 137	Chromium	Chrysene	Cobalt	Copper	Cyanide	DDE[4,4'-]	DDT[4,4'-]	Dieldrin
186-531	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
187-485	6.51E-03	3.19E-04	1.21E-01	7.28E-07	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
197-486	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
198-524	6.15E-03	1.15E-02	0.00E+00	1.67E-06	0.00E+00	8.04E-02	1.86E-02	2.74E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
204-523	1.34E-02	0.00E+00	2.28E-01	2.84E-07	3.61E-04	1.99E-01	0.00E+00	2.87E-02	0.00E+00	6.75E-05	6.32E-04	1.53E-02
230-477	6.51E-03	3.19E-04	1.21E-01	7.28E-07	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
232-520	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
239-477	6.51E-03	3.19E-04	1.21E-01	7.28E-07	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
240-487	0.00E+00	0.00E+00	8.81E-02	0.00E+00	0.00E+00	0.00E+00	1.08E-01	1.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
252-473	6.51E-03	3.19E-04	1.21E-01	7.28E-07	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
253-491	1.89E-02	9.56E-03	6.28E-02	6.43E-08	1.17E-03	2.73E-01	3.92E-03	4.55E-02	0.00E+00	1.60E-03	2.12E-02	3.62E-01
261-513	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
277-484	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.44E-02	1.84E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
280-470	6.51E-03	3.19E-04	1.21E-01	7.28E-07	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
282-480	0.00E+00	0.00E+00	1.57E+00	0.00E+00	0.00E+00	0.00E+00	7.38E-02	7.93E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
287-480	0.00E+00	0.00E+00	2.59E+00	0.00E+00	0.00E+00	0.00E+00	1.49E-01	5.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
289-467	6.51E-03	3.19E-04	1.21E-01	7.28E-07	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
291-468	6.51E-03	3.19E-04	1.21E-01	7.28E-07	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
292-475	0.00E+00	0.00E+00	1.78E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
294-478	0.00E+00	0.00E+00	0.00E+00	1.43E-06	0.00E+00	0.00E+00	0.00E+00	1.54E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
294-507	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
310-477	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
315-481	1.89E-02	9.56E-03	6.28E-02	5.76E-05	5.61E-05	1.94E-01	3.92E-03	4.55E-02	0.00E+00	1.60E-03	2.12E-02	3.62E-01
315-502	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
343-504	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
348-466	6.51E-03	3.19E-04	1.21E-01	3.05E-05	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
351-464	4.77E-03	2.39E-03	2.37E-01	1.66E-05	5.17E-04	4.37E-02	0.00E+00	1.17E-02	0.00E+00	2.08E-04	1.95E-03	4.71E-02
354-501	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
358-464	6.51E-03	3.19E-04	1.21E-01	2.59E-05	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
362-498	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
378-493	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
381-493	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
382-493	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
393-496	6.15E-03	1.15E-02	2.86E-01	4.15E-08	0.00E+00	8.04E-02	0.00E+00	4.97E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
398-453	6.51E-03	3.19E-04	1.21E-01	1.31E-05	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
413-492	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
429-481	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
457-463	4.84E-03	0.00E+00	2.23E-01	8.49E-07	4.48E-04	7.26E-03	3.21E-03	2.27E-02	2.24E-04	2.15E-04	2.01E-03	4.86E-02
461-457	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
468-457	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
471-445	6.51E-03	3.19E-04	1.21E-01	3.82E-06	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
473-447	6.51E-03	3.19E-04	1.21E-01	3.65E-06	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
475-456	6.15E-03	1.15E-02	8.56E-02	1.05E-06	0.00E+00	8.04E-02	1.29E-02	4.21E-02	0.00E+00	1.99E-04	2.99E-03	4.68E-02
479-449	6.51E-03	3.19E-04	1.21E-01	3.26E-06	2.70E-04	8.07E-02	2.25E-03	4.97E-02	1.14E-03	8.29E-04	1.54E-02	1.86E-01
527-445	0.00E+00	0.00E+00	2.79E-01	1.54E-06	0.00E+00	0.00E+00	0.00E+00	4.50E-02	0.00E+00	2.76E-04	3.21E-03	6.23E-02
542-450	1.55E-03	2.23E-02	8.45E-02	9.31E-07	0.00E+00	4.46E-02	3.96E-03	2.50E-02	1.27E-03	1.96E-04	1.94E-03	4.44E-02
Mean	5.60E-03	5.55E-03	2.27E-01	3.98E-06	1.32E-04	7.08E-02	1.83E-02	5.62E-02	3.54E-04	4.03E-04	6.65E-03	9.12E-02
Std. Dev.	4.03E-03	6.08E-03	4.86E-01	1.02E-05	2.17E-04	5.29E-02	3.59E-02	4.15E-02	5.31E-04	4.09E-04	6.87E-03	9.15E-02

Table A-2 (a). cont.

Nest Site Col-Row	Endrin	Endrin Aldehyde	Fluoranthene	Fluorene	Lead	Manganese	Mercury	Mercury (methyl)	Naphthalene	Nickel	Phenanthrene
186-531	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	2.41E-03	7.90E-02	1.73E-01	0.00E+00	2.01E-02
187-485	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
197-486	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.94E-01	0.00E+00	1.12E-03	0.00E+00	0.00E+00	1.63E-04	0.00E+00
198-524	7.95E-03	7.95E-03	8.38E-03	6.14E-04	2.73E-02	4.30E-01	2.59E-04	7.65E-02	1.73E-01	2.40E-04	2.01E-02
204-523	2.47E-03	2.47E-03	3.52E-02	4.97E-04	2.29E-01	9.57E-02	2.33E-03	1.13E-01	1.57E-01	0.00E+00	7.25E-02
230-477	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
232-520	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	2.11E-03	7.01E-02	1.73E-01	0.00E+00	2.01E-02
239-477	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
240-487	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-03	0.00E+00
252-473	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
253-491	5.85E-02	5.85E-02	2.81E-02	4.39E-03	2.28E-01	0.00E+00	5.59E-04	2.39E-02	1.15E+00	0.00E+00	5.20E-02
261-513	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.92E-03	6.44E-02	1.73E-01	0.00E+00	2.01E-02
277-484	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.86E-01	2.29E-02	0.00E+00	0.00E+00	0.00E+00	1.57E-03	0.00E+00
280-470	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
282-480	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E-03	0.00E+00
287-480	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.92E-02	5.02E-01	0.00E+00	0.00E+00	0.00E+00	4.21E-03	0.00E+00
289-467	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
291-468	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
292-475	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.37E-01	0.00E+00	5.17E-02	0.00E+00	0.00E+00	1.80E-03	0.00E+00
294-478	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-01	5.38E-02	1.54E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
294-507	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.72E-03	5.84E-02	1.73E-01	0.00E+00	2.01E-02
310-477	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.77E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
315-481	5.85E-02	5.85E-02	1.41E-02	2.32E-03	1.21E-01	0.00E+00	5.59E-04	2.39E-02	6.65E-01	0.00E+00	3.61E-02
315-502	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.58E-03	5.43E-02	1.73E-01	0.00E+00	2.01E-02
343-504	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.40E-03	4.89E-02	1.73E-01	0.00E+00	2.01E-02
348-466	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
351-464	7.61E-03	7.61E-03	6.32E-03	4.07E-04	9.01E-02	9.82E-03	9.57E-04	3.62E-02	1.33E-01	0.00E+00	9.03E-03
354-501	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.33E-03	4.67E-02	1.73E-01	0.00E+00	2.01E-02
358-464	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
362-498	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.27E-03	4.51E-02	1.73E-01	0.00E+00	2.01E-02
378-493	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.17E-03	4.21E-02	1.73E-01	0.00E+00	2.01E-02
381-493	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.15E-03	4.14E-02	1.73E-01	0.00E+00	2.01E-02
382-493	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	1.14E-03	4.12E-02	1.73E-01	0.00E+00	2.01E-02
393-496	7.95E-03	7.95E-03	8.38E-03	6.14E-04	1.32E-02	0.00E+00	1.75E-03	3.90E-02	1.73E-01	0.00E+00	2.01E-02
398-453	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
413-492	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	9.46E-04	3.53E-02	1.73E-01	0.00E+00	2.01E-02
429-481	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	8.60E-04	3.28E-02	1.73E-01	0.00E+00	2.01E-02
457-463	7.85E-03	7.85E-03	1.07E-03	6.09E-04	4.11E-02	1.72E-02	7.58E-04	0.00E+00	1.73E-01	0.00E+00	1.46E-02
461-457	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	6.17E-04	2.55E-02	1.73E-01	0.00E+00	2.01E-02
468-457	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	5.45E-04	2.34E-02	1.73E-01	0.00E+00	2.01E-02
471-445	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
473-447	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
475-456	7.95E-03	7.95E-03	8.38E-03	6.14E-04	5.16E-02	2.19E-01	5.02E-04	2.21E-02	1.73E-01	0.00E+00	2.01E-02
479-449	2.78E-02	2.97E-02	7.93E-03	8.39E-04	6.85E-02	1.50E-02	9.71E-04	3.62E-02	2.37E-01	0.00E+00	1.72E-02
527-445	1.01E-02	1.01E-02	0.00E+00	0.00E+00	9.04E-02	0.00E+00	3.39E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
542-450	7.17E-03	7.17E-03	3.78E-03	3.80E-04	1.78E-02	2.10E-02	2.19E-04	1.37E-02	1.09E-01	0.00E+00	9.12E-03
Mean	1.43E-02	1.48E-02	7.45E-03	6.64E-04	9.04E-02	1.18E-01	5.38E-03	3.32E-02	1.86E-01	2.31E-04	1.69E-02
Std. Dev.	1.41E-02	1.46E-02	6.35E-03	6.87E-04	9.52E-02	1.42E-01	2.36E-02	2.43E-02	1.84E-01	7.38E-04	1.30E-02

Table A-2 (a). cont.

Nest Site Col-Row	Plutonium 239	Pyrene	Selenium	Silver	Thallium	Thorium 232	Titanium	Uranium	Vanadium	Zinc
186-531	1.96E-09	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
187-485	0.00E+00	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
197-486	3.54E-07	0.00E+00	1.13E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
198-524	4.68E-10	1.34E-02	1.22E-01	2.01E-05	1.22E+00	0.00E+00	5.41E-01	1.74E-02	7.05E-02	7.29E-03
204-523	4.94E-07	5.42E-02	3.65E-01	1.55E-03	2.42E+00	0.00E+00	9.67E-01	0.00E+00	0.00E+00	2.61E-01
230-477	6.70E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
232-520	4.72E-07	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
239-477	6.48E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
240-487	0.00E+00	0.00E+00	0.00E+00	5.08E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E+00	6.12E-02
252-473	6.14E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
253-491	3.35E-10	6.77E-02	2.10E-01	1.53E-03	3.45E+00	8.30E-08	0.00E+00	0.00E+00	0.00E+00	1.17E-01
261-513	3.11E-07	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
277-484	4.62E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.78E+00	2.71E-01
280-470	5.48E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
282-480	2.66E-07	0.00E+00	2.75E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.00E-01	4.47E-01
287-480	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E+00	0.00E+00
289-467	5.30E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
291-468	5.25E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
292-475	2.36E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-01	9.79E-01
294-478	1.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E+00	0.00E+00
294-507	2.00E-07	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
310-477	1.58E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E+00	2.22E-01
315-481	9.94E-08	2.34E-02	2.10E-01	1.53E-03	3.45E+00	8.30E-08	0.00E+00	0.00E+00	0.00E+00	3.43E-02
315-502	1.48E-07	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
343-504	8.04E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
348-466	4.17E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
351-464	3.66E-08	9.15E-03	2.42E-01	6.04E-03	4.86E-01	1.89E-08	1.79E-01	4.22E-03	0.00E+00	1.06E-01
354-501	8.45E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
358-464	4.00E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
362-498	7.53E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
378-493	6.00E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
381-493	5.71E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
382-493	5.64E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
393-496	7.03E-08	1.34E-02	1.87E-01	6.27E-03	9.43E+00	0.00E+00	5.41E-01	1.74E-02	0.00E+00	0.00E+00
398-453	3.38E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
413-492	2.15E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
429-481	3.01E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
457-463	1.45E-07	1.60E-03	4.68E-02	2.38E-03	5.78E+00	5.12E-08	0.00E+00	0.00E+00	8.82E-03	5.14E-02
461-457	1.15E-07	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
468-457	1.01E-07	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
471-445	2.50E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
473-447	2.48E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
475-456	9.33E-08	1.34E-02	2.01E-01	2.14E-03	4.73E+00	0.00E+00	5.41E-01	1.74E-02	3.53E-02	4.30E-02
479-449	2.41E-08	3.53E-02	2.10E-01	4.55E-03	6.08E-02	3.21E-08	0.00E+00	6.50E-03	0.00E+00	3.71E-02
527-445	2.41E-08	0.00E+00	7.95E-02	2.85E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
542-450	3.75E-08	6.33E-03	1.48E-01	1.11E-03	1.05E+00	0.00E+00	3.42E-01	2.49E-03	0.00E+00	0.00E+00
Mean	1.13E-07	1.87E-02	4.16E-01	3.64E-03	2.25E+00	1.42E-08	2.44E-01	8.78E-03	2.53E-01	8.10E-02
Std. Dev.	1.93E-07	1.60E-02	1.64E+00	7.32E-03	2.49E+00	2.15E-08	2.83E-01	7.39E-03	6.98E-01	1.58E-01

Table A-2. cont.

b) Mexican Spotted Owl

Nest Site Col-Row	Americium 241	Aroclor 1254	Aroclor 1260	Arsenic	Barium	Bis(2-ethylhexyl) phthalate	Boron	Cadmium	Cesium-137	Chromium	Cobalt
129-489	1.85E-08	3.34E-01	2.73E-02	0.00E+00	4.02E-03	4.79E-01	2.32E-04	1.48E-02	1.37E-06	2.79E-04	8.30E-04
136-481	7.40E-09	1.34E-01	1.09E-02	0.00E+00	1.61E-03	1.91E-01	9.27E-05	5.91E-03	5.47E-07	1.11E-04	3.31E-04
138-490	8.43E-09	1.52E-01	1.24E-02	0.00E+00	1.83E-03	2.19E-01	1.06E-04	6.74E-03	6.23E-07	1.27E-04	3.78E-04
166-496	9.01E-09	1.63E-01	1.32E-02	0.00E+00	1.96E-03	2.32E-01	1.13E-04	7.20E-03	6.66E-07	1.36E-04	4.04E-04
169-499	6.26E-09	1.13E-01	9.20E-03	0.00E+00	1.36E-03	1.62E-01	7.85E-05	5.01E-03	4.63E-07	9.42E-05	2.81E-04
189-490	1.74E-08	3.30E-01	2.56E-02	0.00E+00	3.78E-03	4.50E-01	2.18E-04	1.39E-02	1.29E-06	2.62E-04	7.80E-04
197-477	1.71E-08	1.85E+00	2.52E-02	0.00E+00	3.71E-03	4.42E-01	2.14E-04	1.37E-02	1.26E-06	2.57E-04	7.65E-04
239-477	1.69E-08	1.04E+00	2.49E-02	0.00E+00	4.38E-03	4.38E-01	2.12E-04	1.35E-02	1.25E-06	2.55E-04	1.27E-03
254-478	8.96E-09	6.52E-01	1.63E-01	0.00E+00	1.37E-03	4.86E-01	2.73E-04	4.94E-03	1.38E-06	4.47E-04	3.05E-04
267-462	7.48E-09	3.52E-01	3.72E-02	0.00E+00	1.62E-03	1.94E-01	9.38E-05	5.98E-03	5.53E-07	1.13E-04	3.35E-04
268-478	1.47E-08	5.74E-01	7.32E-02	7.84E-06	4.63E-03	3.81E-01	1.85E-04	1.18E-02	1.09E-06	2.22E-04	7.18E-04
271-465	1.34E-08	5.09E-01	6.64E-02	0.00E+00	2.90E-03	3.46E-01	1.67E-04	1.07E-02	9.88E-07	2.01E-04	5.99E-04
294-478	1.83E-09	2.95E-01	6.50E-02	6.32E-05	1.72E-03	1.39E-01	8.28E-05	2.69E-04	1.45E-07	6.76E-04	1.97E-04
Mean	**1.13E-08**	**5.00E-01**	**4.25E-02**	**5.47E-06**	**2.68E-03**	**3.20E-01**	**1.59E-04**	**8.80E-03**	**8.95E-07**	**2.45E-04**	**5.53E-04**
Std Dev.	**5.28E-09**	**4.82E-01**	**4.23E-02**	**1.75E-05**	**1.25E-03**	**1.33E-01**	**6.73E-05**	**4.52E-03**	**4.12E-07**	**1.62E-04**	**3.06E-04**

Nest Site Col-Row	Copper	Cyanide	DDE[4,4'-]	DDT[4,4'-]	Dieldrin	Endrin	Endrin Aldehyde	Lead	Manganese	Mercury	Mercury (methyl)
129-489	2.25E-02	8.59E-01	2.67E-01	1.56E-01	3.19E-02	1.87E-01	2.00E-01	1.50E-01	3.69E-04	5.88E-02	1.07E-01
136-481	8.97E-03	3.43E-01	1.07E-01	6.24E-02	1.28E-02	7.49E-02	8.00E-02	6.00E-02	1.47E-04	2.35E-02	4.29E-02
138-490	1.02E-02	3.91E-01	1.21E-01	7.07E-02	1.44E-02	8.44E-02	9.02E-02	6.84E-02	1.68E-04	2.68E-02	4.89E-02
166-496	1.09E-02	4.18E-01	1.29E-01	7.58E-02	1.55E-02	9.08E-02	9.71E-02	7.31E-02	1.79E-04	2.86E-02	5.22E-02
169-499	7.60E-03	2.91E-01	8.98E-02	5.26E-02	1.07E-02	6.30E-02	6.74E-02	5.08E-02	1.25E-04	1.99E-02	3.63E-02
189-490	2.11E-02	8.08E-01	2.51E-01	1.47E-01	3.00E-02	1.76E-01	1.88E-01	1.42E-01	3.47E-04	5.58E-02	1.01E-01
197-477	2.07E-02	7.93E-01	2.46E-01	1.44E-01	2.95E-02	1.73E-01	1.85E-01	1.39E-01	3.40E-04	5.42E-02	9.91E-02
239-477	2.05E-02	7.86E-01	2.44E-01	1.43E-01	2.92E-02	1.71E-01	1.83E-01	1.48E-01	1.12E-03	5.37E-02	9.82E-02
254-478	5.74E-02	1.01E+00	2.44E-01	3.11E-01	2.15E-02	1.31E-01	1.35E-01	1.36E-01	1.23E-04	7.86E-02	1.26E-01
267-462	9.08E-03	3.47E-01	1.08E-01	6.31E-02	1.29E-02	7.58E-02	8.10E-02	6.07E-02	1.49E-04	2.38E-02	4.34E-02
268-478	1.80E-02	6.84E-01	2.12E-01	1.24E-01	2.54E-02	1.49E-01	1.59E-01	1.20E-01	3.13E-04	4.72E-02	8.54E-02
271-465	1.62E-02	6.20E-01	1.93E-01	1.13E-01	2.30E-02	1.35E-01	1.45E-01	1.09E-01	2.66E-04	4.24E-02	7.75E-02
294-478	1.34E-02	3.07E-01	3.57E-02	3.22E-02	4.36E-03	2.72E-02	2.74E-02	6.94E-02	3.22E-05	3.82E-02	3.84E-02
Mean	**1.82E-02**	**5.89E-01**	**1.73E-01**	**1.15E-01**	**2.01E-02**	**1.18E-01**	**1.26E-01**	**1.02E-01**	**2.83E-04**	**4.24E-02**	**7.36E-02**
Std Dev.	**1.29E-02**	**2.49E-01**	**7.71E-02**	**7.21E-02**	**8.86E-03**	**5.19E-02**	**5.56E-02**	**3.88E-02**	**2.73E-04**	**1.76E-02**	**3.11E-02**

Table A-2 (b). cont.

Nest Site Col-Row	Naphthalene	Nickel	Plutonium 239	Selenium	Silver	Thorium 232	Uranium	Vanadium	Zinc
129-489	9.86E-02	0.00E+00	0.00E+00	3.61E-02	4.25E-03	3.67E-07	1.85E-04	0.00E+00	3.69E-02
136-481	3.94E-02	0.00E+00	0.00E+00	1.44E-02	1.70E-03	1.47E-07	7.38E-05	0.00E+00	1.47E-02
138-490	4.42E-02	0.00E+00	0.00E+00	1.65E-02	1.93E-03	1.67E-07	8.42E-05	0.00E+00	1.68E-02
166-496	4.77E-02	0.00E+00	0.00E+00	1.76E-02	2.07E-03	1.79E-07	8.99E-05	0.00E+00	1.79E-02
169-499	3.31E-02	0.00E+00	0.00E+00	1.22E-02	1.44E-03	1.24E-07	6.25E-05	0.00E+00	1.25E-02
189-490	9.27E-02	6.83E-06	6.36E-10	3.40E-02	3.99E-03	3.45E-07	1.74E-04	0.00E+00	3.47E-02
197-477	9.09E-02	0.00E+00	0.00E+00	3.33E-02	3.92E-03	3.39E-07	1.71E-04	0.00E+00	3.40E-02
239-477	9.02E-02	0.00E+00	4.91E-07	3.32E-02	3.88E-03	3.36E-07	1.69E-04	0.00E+00	3.84E-02
254-478	3.29E-02	0.00E+00	4.36E-07	3.11E-02	1.60E-03	4.32E-07	1.82E-04	7.11E-04	2.80E-02
267-462	3.98E-02	0.00E+00	1.58E-07	1.46E-02	1.72E-03	1.48E-07	7.47E-05	0.00E+00	1.49E-02
268-478	7.84E-02	0.00E+00	3.91E-07	2.88E-02	3.43E-03	2.92E-07	1.47E-04	3.57E-03	2.97E-02
271-465	7.11E-02	0.00E+00	3.53E-07	2.61E-02	3.07E-03	2.65E-07	1.33E-04	0.00E+00	2.66E-02
294-478	5.71E-04	1.69E-05	6.88E-08	2.85E-02	7.89E-05	1.32E-07	4.69E-06	7.55E-03	2.39E-02
Mean	**5.84E-02**	**1.83E-06**	**1.46E-07**	**2.51E-02**	**2.54E-03**	**2.52E-07**	**1.19E-04**	**9.09E-04**	**2.53E-02**
Std Dev.	**3.04E-02**	**4.91E-06**	**1.96E-07**	**8.75E-03**	**1.29E-03**	**1.06E-07**	**5.75E-05**	**2.23E-03**	**9.17E-03**

Table A-2. cont.

c) Western Bluebird

Nest Site Col-Row	Americium 241	Aroclor 1254	Aroclor 1260	Arsenic	Barium	Bis(2-ethylhexyl) phthalate	Boron	Cadmium	Cesium-137	Chromium (total)	Cobalt
186-531	0.00E+00	4.02E-01	2.90E-02	9.57E-03	6.01E-02	1.77E-01	5.73E-02	6.41E-02	1.30E-06	0.00E+00	2.15E-02
187-485	3.60E-08	2.97E+00	3.65E-02	0.00E+00	2.46E-02	2.35E-01	1.98E-03	1.13E-01	1.13E-06	5.48E-04	4.69E-03
190-487	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
190-531	0.00E+00	4.02E-01	2.90E-02	9.57E-03	6.01E-02	1.77E-01	5.73E-02	6.41E-02	1.30E-06	0.00E+00	2.15E-02
193-528	0.00E+00	4.91E-01	3.54E-02	1.17E-02	7.34E-02	2.17E-01	7.00E-02	7.84E-02	1.59E-06	0.00E+00	2.63E-02
195-508	1.06E-06	1.82E+00	2.34E-02	9.40E-04	0.00E+00	1.63E-01	0.00E+00	4.41E-01	1.84E-06	2.37E-03	1.34E-02
197-488	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.10E-02	1.55E-01	0.00E+00	2.51E-01	0.00E+00	0.00E+00	0.00E+00
204-523	6.77E-06	4.38E+01	4.61E-01	4.58E-03	0.00E+00	4.29E-02	0.00E+00	8.49E-01	1.32E-05	6.71E-04	8.34E-03
227-481	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
230-477	3.60E-08	1.86E+00	3.65E-02	0.00E+00	2.46E-02	2.35E-01	1.98E-03	1.13E-01	1.13E-06	5.48E-04	4.69E-03
232-478	2.88E-08	1.46E+00	2.92E-02	0.00E+00	1.97E-02	1.88E-01	1.58E-03	9.05E-02	9.05E-07	4.39E-04	3.75E-03
232-520	5.17E-07	5.02E-01	2.17E-02	1.20E-02	7.51E-02	2.22E-01	7.16E-02	8.01E-02	1.63E-06	0.00E+00	2.69E-02
239-477	3.60E-08	1.65E+00	3.65E-02	0.00E+00	2.46E-02	2.35E-01	1.98E-03	1.13E-01	1.13E-06	5.48E-04	4.69E-03
252-473	3.60E-08	1.27E+00	1.23E-01	0.00E+00	2.46E-02	2.35E-01	1.98E-03	1.13E-01	1.13E-06	5.48E-04	4.69E-03
253-491	2.88E-08	1.46E+00	7.33E-02	6.86E-04	0.00E+00	5.45E-01	4.75E-02	4.70E-02	7.98E-08	1.92E-03	6.53E-03
259-504	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.37E-02	0.00E+00	0.00E+00	0.00E+00
261-482	0.00E+00	0.00E+00	0.00E+00	3.80E-02	1.91E-01	0.00E+00	0.00E+00	5.82E-01	7.08E-07	0.00E+00	0.00E+00
261-513	5.17E-07	5.02E-01	2.17E-02	1.20E-02	7.51E-02	2.22E-01	7.16E-02	8.01E-02	1.63E-06	0.00E+00	2.69E-02
264-477	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.47E-02
265-488	0.00E+00	0.00E+00	0.00E+00	1.19E-02	9.60E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-01
266-480	9.25E-09	0.00E+00	0.00E+00	2.80E-02	4.82E-01	0.00E+00	0.00E+00	0.00E+00	4.32E-07	0.00E+00	2.65E-02
268-486	3.25E-08	0.00E+00	0.00E+00	0.00E+00	6.19E-01	5.97E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-01
273-487	2.65E-09	0.00E+00	0.00E+00	1.07E-02	5.96E-01	0.00E+00	0.00E+00	0.00E+00	3.28E-07	0.00E+00	1.23E-01
276-511	5.05E-07	4.91E-01	2.12E-02	1.17E-02	7.34E-02	2.17E-01	7.00E-02	7.84E-02	1.59E-06	0.00E+00	2.63E-02
277-484	0.00E+00	0.00E+00	0.00E+00	2.16E-04	5.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.45E-02
280-470	3.60E-08	5.45E-01	1.23E-01	0.00E+00	2.46E-02	2.35E-01	1.98E-03	1.13E-01	1.13E-06	5.48E-04	4.69E-03
289-467	3.60E-08	4.72E-01	1.23E-01	0.00E+00	2.46E-02	2.35E-01	1.98E-03	1.13E-01	1.13E-06	5.48E-04	4.69E-03
290-481	7.58E-05	0.00E+00	0.00E+00	6.70E-03	1.02E-02	0.00E+00	0.00E+00	8.87E+00	1.09E-03	0.00E+00	1.16E-02
292-475	2.29E-08	0.00E+00	3.08E-02	2.07E-02	1.33E-01	0.00E+00	0.00E+00	4.20E-01	0.00E+00	0.00E+00	5.79E-03
294-478	2.77E-07	0.00E+00	0.00E+00	2.07E-02	6.46E-02	0.00E+00	0.00E+00	0.00E+00	3.49E-07	0.00E+00	0.00E+00
294-507	5.62E-07	5.47E-01	2.36E-02	1.30E-02	8.17E-02	2.41E-01	7.80E-02	8.73E-02	1.78E-06	0.00E+00	2.93E-02
298-478	1.25E-07	0.00E+00	0.00E+00	2.82E-02	9.48E-02	1.61E+00	0.00E+00	6.56E-01	1.13E-06	0.00E+00	3.86E-02
298-480	6.82E-08	0.00E+00	0.00E+00	1.02E-03	5.14E-01	0.00E+00	0.00E+00	1.11E-01	4.55E-09	0.00E+00	3.39E-02
298-481	1.67E-07	0.00E+00	0.00E+00	4.95E-02	8.95E-02	0.00E+00	0.00E+00	1.32E-01	1.60E-07	0.00E+00	2.95E-02
305-473	0.00E+00	0.00E+00	0.00E+00	3.13E-02	1.35E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01
307-476	7.19E-09	0.00E+00	0.00E+00	8.63E-04	8.82E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.50E-02
310-477	0.00E+00	0.00E+00	0.00E+00	1.51E-02	6.35E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.42E-02
314-463	3.52E-08	4.62E-01	1.20E-01	0.00E+00	2.41E-02	2.29E-01	1.94E-03	1.11E-01	1.11E-06	5.36E-04	4.59E-03
315-502	4.01E-08	5.02E-01	2.17E-02	1.20E-02	7.51E-02	2.22E-01	7.16E-02	8.01E-02	1.63E-06	0.00E+00	2.69E-02
343-504	4.19E-08	5.24E-01	2.26E-02	1.25E-02	7.84E-02	2.31E-01	7.48E-02	8.37E-02	1.70E-06	0.00E+00	2.81E-02
351-464	2.86E-06	5.38E-01	1.02E-01	1.37E-03	1.80E-02	2.41E-01	7.39E-03	1.72E-01	4.35E-05	8.22E-04	3.44E-03
358-464	1.41E-06	5.14E-01	1.34E-01	0.00E+00	2.68E-02	2.55E-01	2.16E-03	1.23E-01	4.42E-05	5.97E-04	5.11E-03
362-498	4.90E-08	6.13E-01	2.65E-02	1.46E-02	9.18E-02	2.71E-01	8.75E-02	9.79E-02	1.99E-06	0.00E+00	3.29E-02
378-493	4.36E-08	5.47E-01	2.36E-02	1.30E-02	8.17E-02	2.41E-01	7.80E-02	8.73E-02	1.78E-06	0.00E+00	2.93E-02
381-493	4.01E-08	5.02E-01	2.17E-02	1.20E-02	7.51E-02	2.22E-01	7.16E-02	8.01E-02	1.63E-06	0.00E+00	2.69E-02

Table A-2 (c). cont.

Nest Site Col-Row	Americium 241	Aroclor 1254	Aroclor 1260	Arsenic	Barium	Bis(2-ethylhexyl) phthalate	Boron	Cadmium	Cesium-137	Chromium (total)	Cobalt
382-493	4.36E-08	5.47E-01	2.36E-02	1.30E-02	8.17E-02	2.41E-01	7.80E-02	8.73E-02	1.78E-06	0.00E+00	2.93E-02
398-453	7.58E-07	5.77E-01	1.50E-01	0.00E+00	3.01E-02	2.87E-01	2.42E-03	1.38E-01	2.48E-05	6.70E-04	5.73E-03
408-496	3.21E-08	4.02E-01	1.73E-02	9.57E-03	6.01E-02	1.77E-01	5.73E-02	6.41E-02	1.30E-06	0.00E+00	2.15E-02
429-481	4.01E-08	5.02E-01	2.17E-02	1.20E-02	7.51E-02	2.22E-01	7.16E-02	8.01E-02	1.63E-06	0.00E+00	2.69E-02
442-444	2.85E-07	4.62E-01	3.57E-02	0.00E+00	2.41E-02	2.29E-01	1.94E-03	1.11E-01	9.68E-06	5.36E-04	4.59E-03
446-445	2.64E-07	4.62E-01	3.57E-02	0.00E+00	2.41E-02	2.29E-01	1.94E-03	1.11E-01	9.01E-06	5.36E-04	4.59E-03
447-445	2.60E-07	4.62E-01	3.57E-02	0.00E+00	2.41E-02	2.29E-01	1.94E-03	1.11E-01	8.87E-06	5.36E-04	4.59E-03
457-463	2.36E-07	4.53E-01	1.98E-02	1.23E-02	5.77E-02	1.97E-01	5.25E-02	1.00E-01	1.46E-06	1.82E-04	2.11E-02
461-457	3.03E-07	5.02E-01	2.17E-02	1.20E-02	7.51E-02	2.22E-01	7.16E-02	8.01E-02	1.63E-06	0.00E+00	2.69E-02
468-457	5.10E-08	5.47E-01	2.36E-02	1.30E-02	8.17E-02	2.41E-01	7.80E-02	8.73E-02	1.78E-06	0.00E+00	2.93E-02
470-444	1.30E-07	3.46E-01	2.67E-02	0.00E+00	1.80E-02	1.72E-01	1.45E-03	8.30E-02	4.52E-06	4.02E-04	3.44E-03
471-445	1.87E-07	5.14E-01	3.97E-02	0.00E+00	2.68E-02	2.55E-01	2.16E-03	1.23E-01	6.52E-06	5.97E-04	5.11E-03
472-447	1.58E-07	4.41E-01	3.40E-02	0.00E+00	2.30E-02	2.19E-01	1.85E-03	1.06E-01	5.52E-06	5.12E-04	4.38E-03
473-447	2.03E-07	5.77E-01	4.46E-02	0.00E+00	3.01E-02	2.87E-01	2.42E-03	1.38E-01	7.08E-06	6.70E-04	5.73E-03
474-446	1.20E-07	3.46E-01	2.67E-02	0.00E+00	1.80E-02	1.72E-01	1.45E-03	8.30E-02	4.18E-06	4.02E-04	3.44E-03
475-456	5.73E-08	6.13E-01	2.65E-02	1.46E-02	9.18E-02	2.71E-01	8.75E-02	9.79E-02	1.99E-06	0.00E+00	3.29E-02
479-449	1.46E-07	4.72E-01	3.65E-02	0.00E+00	2.46E-02	2.35E-01	1.98E-03	1.13E-01	5.13E-06	5.48E-04	4.69E-03
519-445	4.75E-08	3.46E-01	1.42E-02	0.00E+00	3.85E-02	4.09E-02	1.02E-01	5.80E-02	1.06E-06	0.00E+00	6.05E-03
542-450	4.60E-08	5.77E-01	2.36E-02	0.00E+00	6.41E-02	6.82E-02	1.69E-01	9.66E-02	1.77E-06	0.00E+00	1.01E-02
546-451	2.51E-08	3.46E-01	1.42E-02	0.00E+00	3.85E-02	4.09E-02	1.02E-01	5.80E-02	1.06E-06	0.00E+00	6.05E-03
Mean	**1.46E-06**	**1.14E+00**	**3.73E-02**	**7.70E-03**	**1.57E-01**	**1.89E-01**	**2.80E-02**	**2.54E-01**	**2.04E-05**	**2.50E-04**	**2.25E-02**
Std. Dev.	**9.41E-06**	**5.40E+00**	**6.48E-02**	**1.03E-02**	**2.80E-01**	**2.19E-01**	**3.94E-02**	**1.10E+00**	**1.35E-04**	**4.34E-04**	**2.95E-02**

Table A-2 (c). cont.

Nest Site Col-Row	Copper	Cyanide (total)	DDE[4,4'-]	DDT[4,4'-]	Dieldrin	Endrin	Endrin Aldehyde	Lead	Manganese	Mercury	Mercury (methyl)
186-531	6.30E-02	0.00E+00	4.00E-02	2.31E-02	1.46E-02	1.18E-01	1.18E-01	2.95E-01	1.90E-02	2.94E-01	6.87E-01
187-485	9.30E-02	2.43E+00	2.09E-01	1.48E-01	7.25E-02	5.16E-01	5.51E-01	4.90E-01	1.63E-03	1.48E-01	3.93E-01
190-487	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E-01	0.00E+00	3.01E-01	0.00E+00
190-531	6.30E-02	0.00E+00	4.00E-02	2.31E-02	1.46E-02	1.18E-01	1.18E-01	2.95E-01	1.90E-02	2.91E-01	6.81E-01
193-528	7.69E-02	0.00E+00	4.89E-02	2.82E-02	1.79E-02	1.44E-01	1.44E-01	3.61E-01	2.33E-02	3.53E-01	8.25E-01
195-508	1.56E-01	0.00E+00	1.89E-01	2.29E-01	4.97E-02	2.57E-01	2.62E-01	1.56E+00	0.00E+00	1.17E+00	2.42E+00
197-488	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E+00	0.00E+00	1.01E+01	0.00E+00
204-523	1.48E-01	0.00E+00	1.51E-03	5.42E-04	5.30E-04	4.06E-03	4.06E-03	8.44E-01	3.59E-03	1.46E+00	1.09E-01
227-481	1.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.17E-01	0.00E+00	0.00E+00	0.00E+00
230-477	9.30E-02	2.43E+00	2.09E-01	1.48E-01	7.25E-02	5.16E-01	5.51E-01	4.90E-01	1.63E-03	1.48E-01	3.93E-01
232-478	7.44E-02	1.94E+00	1.67E-01	1.19E-01	5.80E-02	4.13E-01	4.41E-01	3.92E-01	1.31E-03	1.18E-01	3.14E-01
232-520	7.87E-02	0.00E+00	5.00E-02	2.88E-02	1.83E-02	1.47E-01	1.47E-01	3.69E-01	2.38E-02	3.23E-01	7.63E-01
239-477	9.30E-02	2.43E+00	2.09E-01	1.48E-01	7.25E-02	5.16E-01	5.51E-01	4.90E-01	1.63E-03	1.48E-01	3.93E-01
252-473	9.30E-02	2.43E+00	2.09E-01	1.48E-01	7.25E-02	5.16E-01	5.51E-01	4.90E-01	1.63E-03	1.48E-01	3.93E-01
253-491	6.81E-02	0.00E+00	3.22E-01	1.64E-01	1.13E-01	8.67E-01	8.67E-01	1.31E+00	0.00E+00	6.81E-02	2.07E-01
259-504	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E+00	0.00E+00	0.00E+00	0.00E+00
261-482	2.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.42E-01	2.84E-03	1.04E+00	0.00E+00
261-513	7.87E-02	0.00E+00	5.00E-02	2.88E-02	1.83E-02	1.47E-01	1.47E-01	3.69E-01	2.38E-02	2.93E-01	6.99E-01
264-477	3.69E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.71E-03	0.00E+00	0.00E+00
265-488	9.21E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.82E-01	1.19E-02	0.00E+00	0.00E+00
266-480	1.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.58E-01	4.17E-02	5.76E-01	0.00E+00
268-486	4.54E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	2.29E-03	0.00E+00	0.00E+00
273-487	1.26E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-01	1.21E-02	0.00E+00	0.00E+00
276-511	7.69E-02	0.00E+00	4.89E-02	2.82E-02	1.79E-02	1.44E-01	1.44E-01	3.61E-01	2.33E-02	2.73E-01	6.56E-01
277-484	2.45E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.88E-01	2.32E-04	0.00E+00	0.00E+00
280-470	9.30E-02	2.43E+00	2.09E-01	1.48E-01	7.25E-02	5.16E-01	5.51E-01	4.90E-01	1.63E-03	1.48E-01	3.93E-01
289-467	9.30E-02	2.43E+00	2.09E-01	1.48E-01	7.25E-02	5.16E-01	5.51E-01	4.90E-01	1.63E-03	1.48E-01	3.93E-01
290-481	3.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.98E-01	3.46E-04	3.08E-01	0.00E+00
292-475	1.06E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.84E-01	5.63E-04	3.94E-01	0.00E+00
294-478	3.10E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.93E-01	3.34E-04	2.29E+00	0.00E+00
294-507	8.57E-02	0.00E+00	5.45E-02	3.14E-02	1.99E-02	1.61E-01	1.61E-01	4.02E-01	2.59E-02	2.86E-01	6.91E-01
298-478	2.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.85E-01	4.69E-03	7.49E-01	0.00E+00
298-480	7.93E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.73E-03	2.91E+00	0.00E+00
298-481	1.23E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.70E-01	1.10E-02	2.53E+00	0.00E+00
305-473	1.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-01	3.47E-02	0.00E+00	0.00E+00
307-476	1.73E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.12E-02	4.91E-03	0.00E+00	0.00E+00
310-477	1.59E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.65E-01	1.79E-02	0.00E+00	0.00E+00
314-463	9.09E-02	2.38E+00	2.04E-01	1.45E-01	7.09E-02	5.04E-01	5.39E-01	4.79E-01	1.60E-03	1.45E-01	3.84E-01
315-502	7.87E-02	0.00E+00	5.00E-02	2.88E-02	1.83E-02	1.47E-01	1.47E-01	3.69E-01	2.38E-02	2.41E-01	5.91E-01
343-504	8.22E-02	0.00E+00	5.23E-02	3.01E-02	1.91E-02	1.54E-01	1.54E-01	3.86E-01	2.49E-02	2.24E-01	5.57E-01
351-464	7.69E-02	1.78E+00	1.74E-01	1.16E-01	6.05E-02	4.35E-01	4.61E-01	6.18E-01	1.63E-03	1.67E-01	4.45E-01
358-464	1.01E-01	2.65E+00	2.28E-01	1.62E-01	7.89E-02	6.00E-01	5.62E-01	5.34E-01	1.78E-03	1.61E-01	4.28E-01
362-498	9.62E-02	0.00E+00	6.12E-02	3.52E-02	2.24E-02	1.80E-01	1.80E-01	4.51E-01	2.91E-02	2.37E-01	5.99E-01
378-493	8.57E-02	0.00E+00	5.45E-02	3.14E-02	1.99E-02	1.61E-01	1.61E-01	4.02E-01	2.59E-02	1.95E-01	4.98E-01
381-493	7.87E-02	0.00E+00	5.00E-02	2.88E-02	1.83E-02	1.47E-01	1.47E-01	3.69E-01	2.38E-02	1.75E-01	4.49E-01

Table A-2 (c). cont.

Nest Site Col-Row	Copper	Cyanide (total)	DDE[4,4'-]	DDT[4,4'-]	Dieldrin	Endrin	Endrin Aldehyde	Lead	Manganese	Mercury	Mercury (methyl)
382-493	8.57E-02	0.00E+00	5.45E-02	3.14E-02	1.99E-02	1.61E-01	1.61E-01	4.02E-01	2.59E-02	1.90E-01	4.88E-01
398-453	1.14E-01	2.97E+00	2.55E-01	1.81E-01	8.86E-02	6.30E-01	6.74E-01	5.99E-01	1.99E-03	1.81E-01	4.80E-01
408-496	6.30E-02	0.00E+00	4.00E-02	2.31E-02	1.46E-02	1.18E-01	1.18E-01	2.95E-01	1.90E-02	1.20E-01	3.18E-01
429-481	7.87E-02	0.00E+00	5.00E-02	2.88E-02	1.83E-02	1.47E-01	1.47E-01	3.69E-01	2.38E-02	1.31E-01	3.56E-01
442-444	9.09E-02	2.38E+00	2.04E-01	1.45E-01	7.09E-02	5.04E-01	5.39E-01	4.79E-01	1.60E-03	1.45E-01	3.84E-01
446-445	9.09E-02	2.38E+00	2.04E-01	1.45E-01	7.09E-02	5.04E-01	5.39E-01	4.79E-01	1.60E-03	1.45E-01	3.84E-01
447-445	9.09E-02	2.38E+00	2.04E-01	1.45E-01	7.09E-02	5.04E-01	5.39E-01	4.79E-01	1.60E-03	1.45E-01	3.84E-01
457-463	6.62E-02	9.55E-02	4.75E-02	2.50E-02	1.72E-02	1.37E-01	1.37E-01	3.30E-01	1.78E-02	9.64E-02	2.12E-01
461-457	7.87E-02	0.00E+00	5.00E-02	2.88E-02	1.83E-02	1.47E-01	1.47E-01	3.69E-01	2.38E-02	9.40E-02	2.77E-01
468-457	8.57E-02	0.00E+00	5.45E-02	3.14E-02	1.99E-02	1.61E-01	1.61E-01	4.02E-01	2.59E-02	9.10E-02	2.77E-01
470-444	6.82E-02	1.78E+00	1.53E-01	1.09E-01	5.32E-02	3.78E-01	4.04E-01	3.59E-01	1.20E-03	1.09E-01	2.88E-01
471-445	1.01E-01	2.65E+00	2.28E-01	1.62E-01	7.89E-02	5.62E-01	6.00E-01	5.34E-01	1.78E-03	1.61E-01	4.28E-01
472-447	8.68E-02	2.27E+00	1.95E-01	1.39E-01	6.76E-02	4.81E-01	5.15E-01	4.57E-01	1.52E-03	1.38E-01	3.67E-01
473-447	1.14E-01	2.97E+00	2.55E-01	1.81E-01	8.86E-02	6.30E-01	6.74E-01	5.99E-01	1.99E-03	1.81E-01	4.80E-01
474-446	6.82E-02	1.78E+00	1.53E-01	1.09E-01	5.32E-02	3.78E-01	4.04E-01	3.59E-01	1.20E-03	1.09E-01	2.88E-01
475-456	9.62E-02	0.00E+00	6.12E-02	3.52E-02	2.24E-02	1.80E-01	1.80E-01	4.51E-01	2.91E-02	9.42E-02	2.94E-01
479-449	9.30E-02	2.43E+00	2.09E-01	1.48E-01	7.25E-02	5.16E-01	5.51E-01	4.90E-01	1.63E-03	1.48E-01	3.93E-01
519-445	3.43E-02	1.98E+00	3.63E-02	1.37E-02	1.27E-02	9.74E-02	9.74E-02	9.36E-02	1.68E-03	2.44E-02	1.09E-01
542-450	5.72E-02	3.31E+00	6.04E-02	2.29E-02	2.12E-02	1.62E-01	1.62E-01	1.56E-01	2.80E-03	4.07E-02	1.82E-01
546-451	3.43E-02	1.98E+00	3.63E-02	1.37E-02	1.27E-02	9.74E-02	9.74E-02	9.36E-02	1.68E-03	2.44E-02	1.09E-01
Mean	**1.05E-01**	**8.41E-01**	**8.76E-02**	**5.98E-02**	**3.04E-02**	**2.22E-01**	**2.32E-01**	**6.09E-01**	**1.00E-02**	**4.76E-01**	**3.21E-01**
Std. Dev.	**1.34E-01**	**1.16E+00**	**9.24E-02**	**6.74E-02**	**3.18E-02**	**2.27E-01**	**2.40E-01**	**9.18E-01**	**1.14E-02**	**1.34E+00**	**3.57E-01**

Table A-2 (c). cont.

Nest Site Col-Row	Naphthalene	Nickel	Plutonium 239, 240	Selenium	Silver	Thorium 232	Uranium (total)	Vanadium	Zinc
186-531	7.64E-01	0.00E+00	3.59E-08	1.59E-01	9.93E-03	0.00E+00	2.38E-03	1.18E-01	1.83E-01
187-485	5.47E-01	0.00E+00	0.00E+00	2.08E-01	2.64E-02	1.04E-06	1.11E-03	0.00E+00	1.98E-01
190-487	2.57E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
190-531	7.64E-01	0.00E+00	3.59E-08	1.59E-01	9.93E-03	0.00E+00	2.38E-03	1.18E-01	1.83E-01
193-528	9.33E-01	0.00E+00	4.39E-08	1.95E-01	1.21E-02	0.00E+00	2.91E-03	1.45E-01	2.24E-01
195-508	2.88E-01	0.00E+00	5.02E-05	1.01E-01	4.71E-02	0.00E+00	2.94E-03	8.14E-03	3.05E-01
197-488	0.00E+00	5.82E-03	1.23E-06	0.00E+00	4.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
204-523	7.54E-01	1.25E-03	2.89E-05	1.36E-01	4.32E-02	0.00E+00	0.00E+00	0.00E+00	2.76E-01
227-481	6.51E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.17E-01
230-477	5.47E-01	0.00E+00	1.54E-06	2.08E-01	2.64E-02	1.04E-06	1.11E-03	0.00E+00	1.98E-01
232-478	4.38E-01	0.00E+00	1.22E-06	1.66E-01	2.11E-02	8.34E-07	8.92E-04	0.00E+00	1.58E-01
232-520	9.55E-01	0.00E+00	1.09E-05	1.99E-01	1.24E-02	0.00E+00	2.98E-03	1.48E-01	2.29E-01
239-477	5.47E-01	0.00E+00	1.49E-06	2.08E-01	2.64E-02	1.04E-06	1.11E-03	0.00E+00	1.98E-01
252-473	5.47E-01	0.00E+00	1.40E-06	2.08E-01	2.64E-02	1.04E-06	1.11E-03	0.00E+00	1.98E-01
253-491	1.04E+00	0.00E+00	6.12E-09	1.66E-01	7.09E-03	2.16E-06	0.00E+00	0.00E+00	5.01E-01
259-504	0.00E+00	2.21E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.87E+00
261-482	0.00E+00	0.00E+00	6.69E-07	0.00E+00	2.18E-01	0.00E+00	0.00E+00	1.17E+00	9.99E-01
261-513	9.55E-01	0.00E+00	7.11E-06	1.99E-01	1.24E-02	0.00E+00	2.98E-03	1.48E-01	2.29E-01
264-477	0.00E+00	0.00E+00	7.91E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E+00	1.34E-01
265-488	0.00E+00	0.00E+00	1.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+00	3.44E-01
266-480	0.00E+00	0.00E+00	5.10E-07	0.00E+00	1.68E-01	0.00E+00	0.00E+00	1.64E+00	9.01E-01
268-486	0.00E+00	3.17E-03	1.80E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.92E+00	8.35E-02
273-487	0.00E+00	3.49E-03	7.59E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E+00	2.04E-01
276-511	9.33E-01	0.00E+00	5.73E-06	1.95E-01	1.21E-02	0.00E+00	2.91E-03	1.45E-01	2.24E-01
277-484	0.00E+00	3.19E-04	6.55E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+00	4.65E-01
280-470	5.47E-01	0.00E+00	1.25E-06	2.08E-01	2.64E-02	1.04E-06	1.11E-03	0.00E+00	1.98E-01
289-467	5.47E-01	0.00E+00	1.21E-06	2.08E-01	2.64E-02	1.04E-06	1.11E-03	0.00E+00	1.98E-01
290-481	0.00E+00	4.95E-02	3.96E-05	2.98E-01	2.19E-01	3.64E-07	0.00E+00	1.22E-01	3.41E-01
292-475	0.00E+00	1.30E-03	2.45E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.04E-01	8.94E-01
294-478	0.00E+00	0.00E+00	2.32E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-01	1.34E-02
294-507	1.04E+00	0.00E+00	5.00E-06	2.17E-01	1.35E-02	0.00E+00	3.24E-03	1.61E-01	2.49E-01
298-478	0.00E+00	4.09E-03	1.35E-06	0.00E+00	0.00E+00	3.33E-07	0.00E+00	1.23E+00	4.99E-01
298-480	0.00E+00	0.00E+00	8.38E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+00	1.83E-01
298-481	0.00E+00	0.00E+00	2.16E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.32E-01	1.91E-01
305-473	0.00E+00	8.90E-03	5.78E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.96E+00	4.63E-01
307-476	0.00E+00	0.00E+00	9.73E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E+00	3.55E-02
310-477	0.00E+00	0.00E+00	3.27E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.03E+00	4.79E-01
314-463	5.35E-01	0.00E+00	1.07E-06	2.03E-01	2.58E-02	1.02E-06	1.09E-03	0.00E+00	1.93E-01
315-502	9.55E-01	0.00E+00	3.41E-06	1.99E-01	1.24E-02	0.00E+00	2.98E-03	1.48E-01	2.29E-01
343-504	9.97E-01	0.00E+00	2.31E-06	2.08E-01	1.30E-02	0.00E+00	3.11E-03	1.55E-01	2.39E-01
351-464	8.16E-01	0.00E+00	1.03E-06	2.48E-01	3.34E-02	1.01E-06	1.11E-03	0.00E+00	3.71E-01
358-464	5.96E-01	0.00E+00	9.99E-07	2.26E-01	2.88E-02	1.13E-06	1.21E-03	0.00E+00	2.15E-01
362-498	1.17E+00	0.00E+00	2.11E-06	2.44E-01	1.52E-02	0.00E+00	3.64E-03	1.81E-01	2.80E-01
378-493	1.04E+00	0.00E+00	1.50E-06	2.17E-01	1.35E-02	0.00E+00	3.24E-03	1.61E-01	2.49E-01
381-493	9.55E-01	0.00E+00	1.31E-06	1.99E-01	1.24E-02	0.00E+00	2.98E-03	1.48E-01	2.29E-01

Table A-2 (c). cont.

Nest Site Col-Row	Naphthalene	Nickel	Plutonium 239, 240	Selenium	Silver	Thorium 232	Uranium (total)	Vanadium	Zinc
382-493	1.04E+00	0.00E+00	1.41E-06	2.17E-01	1.35E-02	0.00E+00	3.24E-03	1.61E-01	2.49E-01
398-453	6.69E-01	0.00E+00	9.43E-07	2.54E-01	3.23E-02	1.27E-06	1.36E-03	0.00E+00	2.42E-01
408-496	7.64E-01	0.00E+00	7.32E-07	1.59E-01	9.93E-03	0.00E+00	2.38E-03	1.18E-01	1.83E-01
429-481	9.55E-01	0.00E+00	6.89E-07	1.99E-01	1.24E-02	0.00E+00	2.98E-03	1.48E-01	2.29E-01
442-444	5.35E-01	0.00E+00	6.33E-07	2.03E-01	2.58E-02	1.02E-06	1.09E-03	0.00E+00	1.93E-01
446-445	5.35E-01	0.00E+00	6.22E-07	2.03E-01	2.58E-02	1.02E-06	1.09E-03	0.00E+00	1.93E-01
447-445	5.35E-01	0.00E+00	6.20E-07	2.03E-01	2.58E-02	1.02E-06	1.09E-03	0.00E+00	1.93E-01
457-463	7.00E-01	0.00E+00	2.73E-06	1.55E-01	1.19E-02	3.33E-07	2.18E-03	1.16E-01	2.23E-01
461-457	9.55E-01	0.00E+00	2.63E-06	1.99E-01	1.24E-02	0.00E+00	2.98E-03	1.48E-01	2.29E-01
468-457	1.04E+00	0.00E+00	2.53E-06	2.17E-01	1.35E-02	0.00E+00	3.24E-03	1.61E-01	2.49E-01
470-444	4.01E-01	0.00E+00	4.24E-07	1.52E-01	1.94E-02	7.64E-07	8.17E-04	0.00E+00	1.45E-01
471-445	5.96E-01	0.00E+00	6.25E-07	2.26E-01	2.88E-02	1.13E-06	1.21E-03	0.00E+00	2.15E-01
472-447	5.11E-01	0.00E+00	5.34E-07	1.94E-01	2.47E-02	9.72E-07	1.04E-03	0.00E+00	1.85E-01
473-447	6.69E-01	0.00E+00	6.96E-07	2.54E-01	3.23E-02	1.27E-06	1.36E-03	0.00E+00	2.42E-01
474-446	4.01E-01	0.00E+00	4.16E-07	1.52E-01	1.94E-02	7.64E-07	8.17E-04	0.00E+00	1.45E-01
475-456	1.17E+00	0.00E+00	2.62E-06	2.44E-01	1.52E-02	0.00E+00	3.64E-03	1.81E-01	2.80E-01
479-449	5.47E-01	0.00E+00	5.53E-07	2.08E-01	2.64E-02	1.04E-06	1.11E-03	0.00E+00	1.98E-01
519-445	0.00E+00	0.00E+00	8.57E-07	1.08E-01	4.70E-03	0.00E+00	3.13E-04	0.00E+00	0.00E+00
542-450	0.00E+00	0.00E+00	1.06E-06	1.79E-01	7.84E-03	0.00E+00	5.22E-04	0.00E+00	0.00E+00
546-451	0.00E+00	0.00E+00	6.07E-07	1.08E-01	4.70E-03	0.00E+00	3.13E-04	0.00E+00	0.00E+00
Mean	**9.75E-01**	**1.23E-03**	**3.14E-06**	**1.39E-01**	**2.90E-02**	**3.65E-07**	**1.27E-03**	**5.21E-01**	**3.99E-01**
Std. Dev.	**3.22E+00**	**6.27E-03**	**8.49E-06**	**9.56E-02**	**6.26E-02**	**5.27E-07**	**1.25E-03**	**1.13E+00**	**1.21E+00**

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